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WATERSHED WORK PLAN

CITY OF BROWNING

Glacier County, Montana

Prepared under the authority of the Watershed Protection & Flood Prevention Act (Public law 566, 83rd Congress, 66 Stat.666) as amended.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

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WATERSHED WORK PLAN

CITY OF BROWNING WATERSHED

Glacier County, Montana

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666), as amended.

Prepared by: City of Browning

Blackfeet Tribal Business Council

Glacier County Conservation District

With assistance by:

U. S. Department of Agriculture, Soil Conservation Service

U. S. Department of Agriculture, Forest Service

September 1973

FEB 8 1975

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Glacier County, Montana

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WATERSHED WORK PLAN AGREEMENT

Between the

CITY OF BROWNING

BLACKFEET TRIBAL BUSINESS COUNCIL

GLACIER COUNTY CONSERVATION DISTRICT

(hereinafter referred to as the Sponsoring Local Organization)

State of Montana

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the City of Browning Watershed, State of Montana, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the City of Browning Watershed, State of Montana, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture through the Service hereby agree on the watershed work plan and further agree that the works of improvement as set forth in said plan can be installed in about five years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire with other than PL-566 funds such land rights as will be needed in connection with the works of improvement. (Estimated cost: $84,200)

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894), effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the Sponsoring Local Organization and the Service as follows:

	Sponsoring Local Organization (percent)	Service (percent)	Estimated Relocation Payment Costs* (dollars)
Relocation Payments	19.6	80.4	0

*Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to state law as may be needed in the installation and operation of the works of improvement.

4. The percentages of construction costs ($264,500) of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
Floodwater Retarding Structure	0	100	155,500
Two Floodwater Diversion Structures	0	100	109,000

5. The percentages of the engineering costs ($44,900) to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Cost (dollars)
Floodwater Retarding Structure	0	100	26,400
Two Floodwater Diversion Structures	0	100	18,500

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $600 and $54,700, respectively.

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the availability of appropriations for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

14. No member of or delegate to congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving federal financial assistance.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

CITY OF BROWNING

By _____

Title _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the City of Browning, adopted at a meeting held on

_____.

_____

City Clerk, City of Browning

Date _____

BLACKFEET TRIBAL BUSINESS COUNCIL

By _____

Title _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Blackfeet Tribal Business Council, adopted at a meeting held on

_____.

_____

Secretary, Blackfeet Tribal Business Council

Date _____

GLACIER COUNTY CONSERVATION DISTRICT

By _____

Title _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Glacier County Conservation District, adopted at a meeting held on

_____ .

_____

Secretary, Glacier County Conservation District

Date _____

Appropriate and careful consideration has been given to the environmental statement prepared for this watershed and to the environmental aspects thereof.

SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

Recommended by:

_____

State Conservationist

_____

Date

Approved by:

_____

Administrator

_____

Date

WATERSHED WORK PLAN
CITY OF BROWNING WATERSHED
Glacier County, Montana
September 1973

SUMMARY OF PLAN

The City of Browning Watershed contains 25,210 acres (39.4 square miles) and includes the city of Browning. It is located in Glacier County on the Blackfeet Indian Reservation in northwestern Montana.

The watershed plan was developed and sponsored by the City of Browning, Blackfeet Tribal Business Council, and Glacier County Conservation District. See Project Map, Figure 4.

Watershed Problems

Rangeland in the upper watershed is in good to excellent condition. Some streambank erosion occurs along Willow Creek.

The principal watershed problem is floodwater damages in Browning which occur almost annually.

Project Objectives

The basic objective of the sponsors is to protect Browning from floodwater originating on the watershed above town. Protection is desired from the largest storm expected once in 100 years. A second objective is to reduce erosion and sediment deposition in the watershed and the stream channel.

Measures To Be Installed

Land treatment measures to be installed on rangeland include proper grazing use, planned grazing systems, and related conservation measures.

Structural measures to be installed consist of: (1) a floodwater retarding structure on Willow Creek four miles west and a mile south of Browning; (2) the upper floodwater diversion a mile west of Browning; and (3) the lower floodwater diversion adjacent to Browning.

The floodwater retarding structure will reduce the peak flood flows of Willow Creek. The upper floodwater diversion will convey flood flows from part of the uncontrolled area below the reservoir to Flat Iron Fork which bypasses Browning. The lower floodwater diversion will convey flows from lower areas into Willow Creek.

The floodwater retarding structure on Willow Creek will control runoff from 15.03 square miles or 57 percent of the contributing drainage area above Browning. The floodwater diversion systems will control runoff from an addition 10.36 square miles. Project measures will control 96 percent of the total drainage area and eliminate about 94 percent of the average annual floodwater and sediment damages.

Flood plain management will be provided in conjunction with land treatment and structural measures for the area within the 100-year, "with-project" flood plain.

Environmental Impact

The project will improve community conditions and strengthen overall rural area development on the Blackfeet Indian Reservation. Flood prevention measures will reduce the amount of filth and debris that is flushed into streams and carried into homes.

The project will require the commitment of about 88 acres of rangeland for dams, spillways, borrow areas, sediment pools, dikes, and diversion channels. All but 18 acres in the sediment pools will be reseeded to grass. Project measures will inundate or cover a total of 0.7 miles of stream channel. Free interchange of fish populations on upper Willow Creek will be blocked at the dam site. The project will create 22 additional acres of waterfowl resting area.

No archeological or historical features will be affected by the project.

Project Installation

Structural and land treatment measures will be installed during a 5-year period. Engineering services and land rights acquisition will begin in the first year. Construction activities, including seeding, fencing, and restorative work will be concluded by the fifth year.

Operation and Maintenance

The City of Browning will be responsible for carrying out operation and maintenance of structural works of improvement. Average annual operation and maintenance costs are estimated at $2,960.

Benefits and Costs

The cost of applying land treatment measures on private land, estimated at $4,100, will be borne by the individual landowners in conjunction with assistance as may be provided under going agricultural programs.

The total cost of project structural measures is estimated at $448,900, of which $364,100 will be borne by PL-566 funds and $84,800 by other funds. The total annual benefits ($63,760) divided by total annual costs ($33,870) provides a ratio of 1.9 to 1.0.

Total project costs are estimated at $453,000.

WATERSHED RESOURCES AND ENVIRONMENTAL SETTING

BACKGROUND AND HISTORICAL DATA

The watershed is located on the Blackfeet Indian Reservation with a large part of the watershed area owned by members of the Blackfeet tribe. Browning is the main social and business center for the Blackfeet Indians. Therefore, a brief history of the Blackfeet tribe was considered appropriate as an introduction to this watershed work plan. Information for this section was compiled from various reports dealing with history of the Blackfeet tribe. 1/

The Indians of the Blackfeet Reservation are direct descendants of the Southern Piegans, a division of the loosely knit Blackfeet Confederacy. This Confederacy consists of the Southern Piegans of Montana and the Blood and Northern Blackfeet of Canada, all of Algonquian stock. These tribes were among the most powerful Indian groups of the northwest plains. Although politically independent, the various tribes share a common language and similar customs. The three tribes intermarried and sometimes formed a common front against a common enemy.

The Blackfeet are regarded as the ancients of the Northern Plains. At one time their vast territory, bounded on the west by the Rocky Mountains, extended from the North Saskatchewan River to the headwaters of the Missouri and the present Yellowstone National Park. The Blackfeet, Piegans, and Bloods lived in the Saskatchewan area until about 1730, when they drifted southwest in search of buffalo and became famous as exceptional horsemen, hunters, and warriors. The Blackfeet did not have difficulty with either whites or other Indians until the early 18th century. Inter-Tribal warfare resulted thereafter from competition for better hunting territories and a desire to acquire more and better horses. They quickly became skilled in the art of horse raiding and established a reputation as warriors which demanded the respect of other tribes and whites alike.

For more than a century the Blackfeet were the dominant military power of the northwestern plains and were feared by both neighboring tribes and the white trappers.

1/ Unpublished reports from Blackfeet Agency, Bureau of Indian Affairs files.

By the late 18th century the French and British were trading peacefully with the Blackfeet. However, the trail opened by Lewis and Clark in 1805 brought Americans who wished to trap their own furs, rather than to trade with the Indians. White traders were acceptable--trappers were not.

When the United States entered the picture in the 1840's, the Blackfeet were weak because of previous divisions into small factional bands. The lack of tribal leadership constituted a serious problem for American military and administrative personnel charged with the treaty making, control, and programs.

Several minor peace treaties led to the culmination, in 1851, of the Fort Laramie Treaty between the United States Government and the Blackfeet. This treaty set aside a vast area for the tribe and placed them under the jurisdiction and protection of the United States.

In 1855 the government made a treaty with the Blackfeet and several of their neighboring tribes which provided for use of a large portion of the original reservation as a common hunting territory. The Indians were placed under the responsibility of the War Department where they suffered under authoritative rule with some of the worst programs ever formulated for them.

By a series of treaties beginning in 1855, the Piegans of Montana began relinquishing lands to the federal government in exchange for promised annuities and protection from the depredations of white men in the area. In 1873 and 1874 the southern boundary of the Blackfeet Reservation was moved 200 miles north and the land south opened to settlement. The Blackfeet were forced to accept Reservation living. After the disappearance of the buffalo, the staff of life of the Blackfeet in the 1880's, these once independent people were reduced to a state of dire poverty and dependence upon government assistance for survival.

The confinement of the Indians to a closely watched Reservation controlled by agents and military men was harsh treatment. The Blackfeet were accustomed to a nomadic life of hunting, fishing, gathering, and fighting. Even the horse raiding ceased about 1886. In 1888 additional lands were taken and separate boundaries established for the Blackfeet, Fort Belknap, and Fort Peck Reservations in Montana.

Development in northern Montana moved ahead rapidly following the completion of the Great Northern transcontinental railway in 1893. Small towns began to crop up along the railroad. In the same year the wife of an army officer convinced officials that the Valley of the Wild Flowers was the ideal location for the Indian Agency. Soon after, agency buildings and a hospital were established and in 1897 Browning was a designated townsite.

In 1907 the government decided to reverse its policy of treating the reservation as the property of the entire tribe. Provisions were made to survey the entire reservation and parcel out land to individual tribal members. The act also provided that each family should be given an additional five head of cattle and each district allotted a registered bull. Land allotments were made to 2,450 Blackfeet on the tribal rolls in 1912. Individual parcels amounted to 40 acres of irrigated land and 280 acres of grazing land, or the individual could take 320 acres of grazing land. Acreage was reserved for the townsites of Browning, Blackfoot, Babb, Midville, and several administrative sites necessary to the management of an Indian Reservation. The remaining land was to be sold under the Homestead Act with proceeds deposited in the U. S. Treasury for credit of the Blackfeet and to repay the Government for irrigation projects. However, in 1913, 65,507 acres were set aside as a timber reserve. Following the Act of June 30, 1919, the number of allotments was increased to 3,485. It was also decided to increase the size of the allotment and each individual then received an additional 80 acres giving each one a 400-acre allotment, leaving very little land, if any, to be sold. In 1918 the government provided the rights to patent land so that lands could be traded or sold. Both trust patents and fee patents were provided.

Browning became incorporated in 1919 and contended for the county seat location. However, Cut Bank, the oldest incorporated town in the county, was selected after a vote. The few Blackfeet who had their land patents cast their votes for Browning, although a majority of the Indians could not vote.

Congress passed the Indian Reorganization Act on June 18, 1934, which gave the Blackfeet the right to establish a government. In 1935, a Constitution of the Blackfeet Tribe was drawn up and ratified by the tribal members. In 1936, a Corporate Charter was drawn up and ratified. Out of these laws, a governing body was provided to manage and supervise all tribal property and affairs. This politically organized body, consisting of thirteen members, which later was reduced to nine, is elected by the enrolled members every two years and is known as the Blackfeet Tribal Business Council. The Council elects a chairman, vice chairman, and secretary from among its members and employs a treasurer who is not a member of the Council. The Council is a legislative body, but has the additional duties of administration and the adjudication of laws.

The life and dress of the modern Blackfeet are very much like that of other rural communities of the West. There are approximately 10,500 enrolled members of the Blackfeet Tribe; about 6,000 live within the reservation boundaries. Of the estimated 6,000 Indians living

on the reservation, approximately one-third live in Browning, the agency and tribal headquarters. The remainder reside in widely scattered localities or on their own allotments. Many are more closely identified with non-Indians than with the few remaining full-blood Indians. Approximately 27 percent of those who are enrolled members of the tribe are three-fourths or more Indian blood. Language is sometimes a barrier between this group and the mixed bloods, since many of the latter have little knowledge of the native language. A portion of the older full-bloods still speak only their native tongue. A considerable proportion of the younger generation speak both Blackfeet and English, although many of them have great difficulty with the Blackfeet language or know only a few words of it. The Blackfeet Tribe in the past has been less restrictive in qualifications for membership than most tribes. As a result, more than 26 percent of the enrollees are less than one-fourth Indian blood. However, by referendum, approved August 1962, the tribe restricted future membership to persons of one-fourth or more Blackfeet blood.

P H Y S I C A L D A T A

The City of Browning Watershed is located in Glacier County on the Blackfeet Indian Reservation in northwestern Montana. The watershed contains about 25,210 acres (39.4 square miles) and includes the city of Browning. Browning, with a population in 1970 of 1,700, is 15 miles east of Glacier National Park and about 126 miles northwest of Great Falls, Montana. The population of Glacier County is 10,783.

Glacier County is bordered on the west by the Continental Divide and on the north by the U. S.-Canadian line. All but a small portion of the eastern part of Glacier County is in the Blackfeet Indian Reservation.

The watershed area is about 15 miles long and averages three miles wide. It is located in Water Resource Region 10, Subregion 03, OBE Economic Area 094, and Land Resource Area 046. Browning is located at the eastern edge of the watershed and is the principal town and headquarters for the Blackfeet Tribe, Bureau of Indian Affairs, and Public Health Service.

Willow Creek, the major watershed drainage, originates in the western end of the watershed and flows northeasterly through most of the watershed. It then proceeds easterly through the northern part of Browning. Willow Creek then continues northeasterly about 14 miles to its confluence with Cut Bank Creek. See Figure 4, Project Map.

The drainage north of Willow Creek is designated as the Flat Iron Fork of Willow Creek. This drainage is parallel to Willow Creek in a mostly wide, flat plain. Flat Iron Fork is constricted to form a boggy, spring area about 4.5 miles west of Browning. This area is the source of Browning's water supply through a shallow well and drain tile collection system. Water flows by gravity in a pipeline from the spring through a chlorinator and storage tank to the city. There is sufficient elevation difference between the chlorinator and the city to fill the city water storage tank.

The watershed is on the extreme western portion of a wide glacial plain. The general topography is a rolling plain rising westward to the Continental Divide. The area is typical glacial knob-and-kettle topography. Numerous small, shallow, glacial lakes have formed in pothole areas. Runoff from the pothole areas drains into Willow Creek upstream from Browning. In the upper watershed, Willow Creek has a relatively narrow flood plain bordered in most places by steep bluffs of till. The bluffs ascend gradually into a gently rolling upland plain. Near the upper end of the watershed area the upland plain blends into a steep foothill area adjacent to the high mountain range bordering Glacier National Park. The flood plain of Willow Creek gradually broadens to a half mile in width at Browning. Browning encompasses about 45 city blocks, of which 25 blocks are located on the flood plain and subject to frequent flood damages. Elevation ranges from 4,330 feet at Browning to 5,730 feet in the upper watershed.

The watershed is covered by a mantle of glacial drift which consists of boulders, cobbles, and clay. The boulders and cobbles are predominantly granite, gneiss, and quartzite. Underlying the glacial drift is the Colorado Formation which consists of bluish gray to black shale with thin irregular stratifications of hard shaly sandstone and limestone in concretions.

There are coal, oil, and gas resources on the Blackfeet Reservation. However, these resources are outside the watershed. The development of coal resources has been limited and the extent to which these deposits exist is generally undetermined.

The Blackfeet Reservation has two oil and gas fields partially within, and one field wholly within, the limits of the reservation. The Cut Bank and Blackfoot fields are partly within the reservation. The Reagan field is wholly within the reservation and located near Twin Buttes. In 1960 there were 1,114 producing wells in the Cut Bank field, 50 wells in the Reagan field, and 480 wells in the Blackfoot field. The rate of production in the Reagan and Cut Bank fields is decreasing, but substantial reserves remain. All three fields are outside the watershed.

Titaniferous magnitite deposits averaging 36 percent iron and eight percent titanium exist in several locations on the reservation. These deposits are outside the watershed and not considered commercially valuable under current mining standards.

Extensive deposits of commercial quality gravels and clays exist in the watershed. One gravel pit which has been operated by the Blackfeet Tribal Business Council is located just north of Browning along the Flat Iron Fork of Willow Creek. This pit has now been abandoned. Other deposits of gravel and clay exist in the upper portion of Willow Creek drainage in the watershed.

There is an abundance of ground water available in the valleys of the watershed. Numerous springs and flowing wells exist. There is a high water table in the flood plain area above Browning. Recently installed storm drains have helped reduce the water table in the city.

Soils in the watershed are formed in deep glacial till deposits over shale and sandstone. Soils of the upland plains, which comprise the major portion of the watershed, are predominantly deep stony loams and deep clay loams. These soils have a thin dark-colored topsoil. However, small areas of deep black organic loam soils are common. Soils along the drainageways and in the upland seeped pothole swales are poorly drained. They are predominantly organic loams with gravelly clay loam subsoils.

The vegetative cover in the watershed is predominantly native grasses. The dominant species include rough fescue, Idaho fescue, bluebunch wheatgrass, green needlegrass, and danthonias. Associated species include lupine and other forbs. In poorly drained areas, vegetative cover consists of tall reedgrasses, tufted hairgrass, slender and bearded wheatgrasses, sedges, rushes, cinquefoil, and scattered willows. Aspen groves are common on the steep foothill area in the upper watershed. The area is used primarily for grazing by sheep and cattle. Native meadows along stream valleys are cut for hay.

There are no critical erosion areas in the watershed. Land treatment that focuses on proper grazing use and livestock management contributes to a low rate of sediment production. Good to excellent vegetative cover in the watershed, as evidenced by good to excellent range condition, is expected to continue.

Land use divisions in the watershed are: 21,845 acres (87 percent) native range; 970 acres (4 percent) irrigated and subirrigated pasture and hayland; 1,350 acres (5 percent) timber land and aspen; 370 acres (1 percent) brushy wildlife habitat; 435 acres (2 percent) urban and built-up; and 240 acres (1 percent) roads and miscellaneous.

The climate type is semiarid characterized by abundant sunshine, low relative humidity, moderate to high wind movement, and large seasonal temperature variations. Most weather is controlled by fronts moving from the northwest out of Canada or from the Pacific. The average annual precipitation as recorded at the weather station in Browning is 15.4 inches with the greatest amount (20 percent) falling during the month of June and two-thirds of the total occurring during the growing season.

The mean annual temperature is 40.5°F. The mean temperature for the coldest month, January, is 18.9°F with the average maximum temperature being 29°F and the average minimum being 8.4°F. July is the warmest month, having a mean temperature of 62.7°F, an average maximum temperature of 78°F, and an average minimum temperature of 45.6°F.

Extreme temperatures of -56°F and 99°F have been recorded. Records show the frost-free period to be about 97 days with the last frost in the spring occurring around June 2 and the first frost in the fall coming around September 8.

Snow accumulates in the watershed during the winter and remains until early summer in the form of windblown drifts.

Stream classification of Willow Creek is "N" (well defined, unmodified channel) above Browning; "M" (previously modified channel--early days to present) within Browning and immediately below the city. This is a perennial "Pr" stream. Flat Iron Fork of Willow Creek is classified as "O" (practically no defined channel), "E" (Ephemeral--flows only during periods of surface runoff). Streams in this area have been classified as $B\text{-}D_1$ by the Montana Water Pollution Control Council. 1/

E C O N O M I C D A T A

Browning is the major trade and social center for the Blackfeet Indian Reservation. Local services available in Browning include

1/ State Classification $B\text{-}D_1$ indicates water that shall be maintained suitable for drinking, culinary, and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection, or other treatment necessary to remove naturally present impurities. These waters shall be maintained suitable for bathing, swimming, and recreation, growth and propagation of salmonid fishes and associated aquatic life, waterfowl, furbearers, agricultural, and industrial uses.

schools, hospital, bank, retail stores, tourist accommodations, Indian agency offices, and headquarters for the Blackfeet tribal government. The primary trade area for the Blackfeet Indian Reservation includes Cut Bank (population 4,004), county seat of Glacier County, as well as the neighboring towns of Shelby and Conrad. Great Falls, about 126 miles to the southeast, is the nearest primary wholesale and distribution center.

Browning's population, according to census data, indicates a decline from 2,011 in 1960 to 1,700 in 1970. However, the population for the Browning-East Glacier Division remained constant during this decade. It is evident that more people at Browning are living outside city limits due to recent housing developments. City officials estimate that about 2,800 people currently live in or adjacent to Browning. The total watershed population, including rural residents above Browning, is estimated at 2,900.

The following is an excerpt from a Bureau of Indian Affairs report and provides an insight into the land ownership features of the watershed:

> "The present boundaries of the Blackfeet Indian Reservation encompass 1,526,000 acres. Of this amount, 156,000 acres are owned by the tribe and 775,000 acres are allotted or owned by individuals. The Blackfeet Agency of the Bureau of Indian Affairs had jurisdiction over 1,077,477 acres of land within the Blackfeet Reservation in 1969. This acreage is comprised of 14 percent tribally-owned land, 72 percent individually Indian-owned land, and 14 percent federal government and other lands administered by BIA. These Blackfeet Reservation lands are used primarily by Indians with 66 percent in Indian use." 1/

Land ownership on the reservation and in the watershed is very complex. The Blackfeet tribe owns some lands in fee simple title. These lands were purchased by the tribe and are on the tax rolls. The tribe also has direct management and control of certain trust lands. The title of these trust lands rests with the United States of America and they are nontaxable. Lands such as the area for the

1/ U. S. Department of the Interior, Bureau of Indian Affairs, Missouri River Basin Investigations Project, The Blackfeet Reservation Area--Its Resources and Development Potential, Report No. 199, April 1972.

Indian agency headquarters are in this category. Both trust lands and fee lands were granted to individual Indians. Trust lands are held in the names of the original allottee or his heirs. In many cases the current allotments for a given parcel may rest with a number of people, all of whom have fractional interests in the parcel. These trust lands are managed by the Indian agency and designated as "Trust Allotted." Individuals, both Indian and non-Indian, may own land in fee simple title. Some lands are also owned by other units of government.

The following is a summary of land ownership status in the watershed: Tribal Trust (USA), 810 acres; Tribal Fee, 1,360 acres; Individual Trust Allotment, 9,230 acres; Individual Fee, 13,410 acres; State of Montana, 20 acres; Glacier County, 50 acres; and other, including city area of Browning, 330 acres.

Cattle and sheep ranch operations are the basic agricultural enterprises in the watershed. Ranchers lease blocks of land which they combine with their privately-owned lands. There are 13 ranch operators with headquarters in the watershed. Most of these units are below the 4,580-acre average for Glacier County. Ranchers have access to markets over county roads and state highways.

Crop production in the watershed is confined primarily to harvesting hay along stream valley bottoms. Hay yields average 0.75 to 1.0 tons per acre. Animal stocking rates on rangeland average 0.44 animal unit months per acre.

The economy of the reservation, and in particular the Browning area, is primarily based upon agriculture and its associated services. Most of the oil and gas production on the reservation is derived from the eastern part which has a greater impact on the Cut Bank area. The market value of crops in Glacier County, according to the 1969 Census of Agriculture, was $4,648,538. The value of livestock and livestock products was $9,199,985.

A total of 4.3 million barrels of oil was produced in Glacier County in 1969. Data for 1971 indicate oil production in Glacier County totaled 8.6 million barrels, valued at $26,167,000. 1/

1/ Montana State Oil and Gas Commission

Land values in the watershed average about $45 per acre for grazing land and $75 per acre for valley bottom meadow hayland. Homes in Browning generally range in value from $3,500 to $15,000. Commercial lots vary in price from $70 to $100 per front foot. Residential lots outside improved areas average $400 for a 50-foot-wide lot. With paved streets and other improvements, lots sell for $2,000-$2,500.

The Blackfeet Indian Reservation, including Browning, is classed as a Title IV area by the Economic Development Administration. A high rate of unemployment and underemployment prevails. Unemployment rates traditionally rise during the fall and winter months. A recent study in 1970 showed that 23 percent of the Blackfeet people were unemployed and had made an effort to find employment. 1/ This same study showed that another 42 percent were not employed and had not made an effort to find employment. The group interviewed included housewives, retired persons, persons seasonally unemployed, and others not actively seeking employment.

The Blackfeet Tribal Business Council, City of Browning, and other local leaders have been instrumental in getting new businesses and community development projects under way in recent years. This has been a great step forward in offering gainful employment.

Tourism is also a growing basic industry for the Blackfeet Reservation area. The reservation is uniquely located next to United States and Canadian national parks as well as national and state wilderness areas. The Blackfeet Reservation itself attracts a certain amount of tourist interest. The Museum of the Plains Indians and a private museum are located in Browning. Tourists traveling across northern Montana to and from Glacier National Park pass through Browning. Although the tourist season is generally short, an expansion of accommodations in Browning has taken place with the recent development of a large motel.

Industrial development in Browning has expanded during recent years. An initial step was the planning and development of an industrial park on the outskirts of the city. Industrial development has included a sawmill-logging operation owned by U. S. Plywood (formerly Chief Mountain Lumber), Blackfeet Indian Developers Incorporated that builds modular homes, a wood products factory, and a recently constructed pencil factory. Employment at U. S. Plywood averages 45; wood products, 45; Blackfeet Indian Developers, 30; and 70 at the pencil factory.

1/ MRBI Report No. 199, op. cit., p. 18.

Recent growth and development in Browning have included low rent and mutual help housing units. A total of 139 units has been constructed. There are 55 units under construction and another 78 units planned. The 194 housing units constructed or under construction are valued at $2,716,000. These housing units have helped to alleviate many poor housing conditions that prevail in Browning where it has been estimated that 60 percent of the houses are in a delapidated or deteriorating condition. 1/

Census data for Glacier County indicate that in 1970 there were 3,582 persons in the labor force, with 87.4 percent employed and 12.6 percent unemployed. Employment in the labor force was distributed percentagewise as follows: agriculture, 13.1; construction, 6.3; manufacturing, 2.8; mining, 10.2; transportation and communications, 3.5; utilities, 2.7; wholesale and retail, 24.1; finance, insurance, and service, 15.1; schools, 9.4; welfare, religious, 1.9; legal and professional, 1.9; and public administration, 9.0. The number of people employed in agriculture decreased 4.9 percent from 1960 to 1970. During this same period, wholesale and retail employment increased 2.5 percent.

Survey data of persons on the Blackfeet Reservation, which are typical of the watershed, indicate the following categories of employment and percentage distribution: agriculture, 7.3; construction, 2.5; transportation and communication, 0.8; wholesale and retail, 5.7; finance, insurance and real estate, 0.8; services, 1.7; government, 16.2; and not applicable or unemployed, 65.0. 1/

Income data obtained in 1970 for Indian household on or near the reservation indicates that average household income for 1969 was $5,428 and per capita income, $1,048. 2/ During this same period, per capita income in Montana was $3,130 and in the United States, $3,687.

Income data were also tabulated by groups for persons in the survey and compared to Montana and U. S. figures. The following data show that there is a much higher percentage of low income households among the Indians as well as a lower percentage of high income households.

1/ Fagg, Harrison and Assoc., Billings, Mont., Browning-Blackfeet Comprehensive Plan, January 1970.

2/ MRBI Report No. 199, op. cit., pp. 14-20.

"Twenty-seven percent of the households had income less than $3,000. This figure is generally used as the poverty level. Only nine percent of the Indian households had an income of over $10,000.

"For the State of Montana, 22.3 percent had income below the $3,000 poverty level, while 22.2 percent had incomes of $10,000 or more. The United States had 17.9 percent below $3,000 and 31.3 percent with $10,000 or more." 1/

FISH AND WILDLIFE RESOURCE DATA

The watershed supports a modest variety of wildlife species, including some furbearing and big game animals, game and nongame birds, and fish. The area is inhabited by mule deer, sharp-tailed grouse, and hares, which provide some hunting. Beaver, mink, and muskrats are trapped along Willow Creek. Waterfowl are the most sought-after game species by non-Indian hunters. Approximately 80 potholes, comprising about 240 acres, provide good nesting sites for ducks as well as resting areas in the spring and fall for migratory species. A variety of song birds, shore birds, and raptors nest and rear their young within the watershed.

Fishing in the watershed is confined primarily to Willow Creek. Local residents creel good catches of rainbow and brook trout. Non-Indian fishing is partially discouraged by the requirement for both a state and reservation license. The upper reaches of Willow Creek are bordered by a thick riparian growth of willows that provides a favorable shaded habitat to trout. See Photo Plate 10 showing the reservoir basin and typical stream habitat in the upper reaches of Willow Creek. This riparian vegetation occurring along Willow Creek and other watercourses in the watershed provide food and shelter for game and nongame species alike, especially during the winter months.

These fish and wildlife resources provide a modest number of hours of outdoor recreation each year in the form of hunting, fishing, trapping, and wildlife observation. All the watershed is within the boundaries of the Blackfeet Indian Reservation with hunting and fishing opportunities being regulated by the Tribal Council.

RECREATION RESOURCES

Accommodations for tourists in Glacier Park are limited. Recently there has been an effort to encourage more private development of

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1/ MRBI Report No. 199, op. cit., p. 15.

facilities in areas near the park. The Blackfeet tribe has started constructing a motel complex on Lower St. Mary Lake shore. A number of other facilities for tourists and local residents are planned near the park and on the Blackfeet Reservation.

Outdoor recreational facilities in the watershed are primarily those provided in connection with the rodeo and ceremonial grounds just west of Browning. Space is provided for overnight camping during special events; however, public use facilities are not provided. The Blackfeet tribe plans to relocate the rodeo grounds and expand the area used for special ceremonies. Overnight camping facilities are planned for several nearby lakes outside the watershed.

It appears that the potential for recreation and tourism development on the Blackfeet Reservation is better than for many other areas in Montana. Browning and surrounding area provide a gateway to many outdoor recreation opportunities and tourist attractions.

ARCHEOLOGICAL DATA

An archeological survey of the potential dam site and reservoir area on Willow Creek was conducted by the University of Montana Statewide Archeological Survey. A single tipi ring was recorded in the survey area. No known antiquities will be endangered by construction in this area. The watershed does not contain any places listed on the National Register of Historic Places.

SOIL, WATER, AND PLANT MANAGEMENT STATUS

The City of Browning Watershed is entirely within the Glacier County Conservation District. Landowners and operators receive assistance from the District to apply land treatment measures. Land management assistance is also provided by the U. S. Department of the Interior, Bureau of Indian Affairs.

Present land use patterns have existed over many years and are expected to continue during the project period. The most common land treatment practices include ponds, proper grazing use, and planned grazing systems.

Five cooperators in the watershed have 9,147 acres of private lands under agreement with the Glacier County Conservation District. In addition, these cooperators control about 10,000 acres of leased lands. Four of the cooperators have basic conservation plans.

About 86 percent of the needed land treatment practices, based on a dollar value, have been applied. This represents more than 90 percent of the presently planned practices. Land treatment measures such as proper grazing use are continuing practices. Application of land treatment practices has been encouraged by the Conservation District, Rural Environmental Assistance Program (REAP) and programs of the Bureau of Indian Affairs.

WATER AND RELATED LAND RESOURCE PROBLEMS

Land Treatment

Land treatment problems in the watershed are minor. All the rangeland, which covers 88 percent of the watershed, is in good to excellent condition. The main land use is for livestock grazing with a small portion of the area used for native hay and pasture production. This use is expected to continue because of the restrictions imposed by the cool climate conditions and glacial soil types.

Floodwater Damage

Floodwater damages occur primarily in the urban area of Browning. Because much of the city, including most of the business district, is located on a low, flat flood plain, flooding is almost an annual occurrence. Flooding problems are further increased because some areas in Browning are actually lower than the Willow Creek channel. Water entering the town from the west side runs more readily down the streets paralleling the creek channel than in the creek channel itself. Also, the Willow Creek channel has restricted sections above Browning. This forces water out on the flood plain causing more floodwater to enter the west side of the city from the flood plain than from Willow Creek. Even small storms create urban flooding because of these conditions.

Attempts have been made to divert floodwaters back into the main Willow Creek channel above the urban area with some channel works. These channels are too small, have little or no grade, and are subject to plugging with the drifted snow which occurs each winter. Drifted snow adds to the flooding problems because it does not always melt ahead of the snow in the upper watershed. This creates further restriction to runoff, particularly snowmelt runoff, and forces even small flows out of bank and into the urban area. Freeze-thaw cycles also contribute to "icing up" and restriction of the channels.

Agricultural damages in contrast to urban damages are usually small. Even though native pastures and hayland are inundated with water, this flooding usually occurs early enough in the growing season that only slight damages occur to the crop. Therefore, agricultural damages are usually limited to some fence washouts, disruption of normal spring livestock feeding operations, and debris deposition.

Significant flooding in Browning has occurred six out of the past eleven years. Major floods inundating a 15 to 20 block area have occurred in 1964, 1958, 1948, and 1920. Damages occur primarily to residences and businesses; however, damage has also been done to utilities, streets, highways, and sewers. Disease and filth problems are created along with debris deposition, sanitary sewer backup, and water pollution. The Red Cross and the State Public Health Service have been called in during flood periods to assist in evacuation, provide temporary shelter, and perform needed medical services. To date no loss of life due to flooding has been recorded.

Although most of the floods in the past have occurred in May or June when snowmelt is combined with rain, there have been floods due to snowmelt only. Some have come as early as January when the warm chinook winds, common to the area, produce high and unseasonably early runoff. Floods due to rainstorms only have also occurred. It is not uncommon to have flooding conditions more than once in a given year.

The historic storm of June 7-8, 1964, produced 5.9 inches of rainfall in a 24-hour period in Browning, creating extensive flooding. Flooding was not as great in this area as in the surrounding areas. The 1964 storm did, however, still produce the worst flood of record in the Browning area and damages caused by this event would approximate the damages caused by the estimated 100-year frequency event. More than 20 businesses were inundated, some to depths of up to two feet. Interviews were conducted with 41 home owners who experienced flood damages. This was estimated to represent about 30 percent of the total number of houses flooded. The Red Cross assisted in providing temporary shelter, food, and medical care. Utilities were interrupted in the city. Sewers and water systems were damaged. Traffic was interrupted on U. S. Highway 2. The Willow Creek bridge on U. S. Highway 89 was washed out west of Browning. Travel was cut off north of Browning on State Highway 464. Business and other normal activities were brought to a standstill. Total damages were estimated at $182,030, adjusted to 1972 prices. This included $43,710 for damages to businesses, including property loss and income loss; $88,040 for residences; $40,060 for city losses involving street, utility, and sewer damages; and $10,220 for highway repairs. Damage to agricultural lands in the watershed was limited to fence washouts, debris deposition on native hay fields, and interruption of normal farming activities. These damages were minor and not evaluated.

A smaller, more recent rainstorm in June 1970 produced 1.85 inches of rainfall in a 24-hour period which approximated the estimated 2-year frequency event. This caused water to run down many of the streets and surround businesses and homes. Damages from a 2-year storm are estimated at about $8,500.

Total average annual floodwater damages in the City of Browning Watershed are estimated at $62,270. This includes $11,980 for damages to businesses; $38,600 for damages to homes; $4,530 for damages to streets, sewers, and highways; and $7,160 of indirect damages, including such things as traffic detours, disruption of community activities, and inoculations. Average annual damages to agriculture are small and unevaluated.

These damages include projected increases expected to occur as the standard of living of the area reaches the level of other surrounding areas. Increased activities in tourist trade, livestock, farming, and local business development will also result in higher levels of damages unless flood protection is provided.

Erosion and Sediment Damages

There are no significant sources of either sheet or gully erosion in the watershed. There is some streambank erosion occurring along the Willow Creek channel, especially where it flows through Browning. Bank erosion in this area has been accelerated by channel modification as a result of city development. Sediment yields in the watershed are estimated at 0.07 to 0.13 tons per acre per year. Sediment and erosion damages are included in the floodwater damage estimates.

Drainage and Irrigation

Only minor problems regarding drainage or irrigation on agricultural lands are present in the watershed.

A high water table in the urban area of Browning has caused some problems to basements of businesses and homes. However, recent installation of new storm sewers with incorporated subsurface drainage has helped to alleviate the problem.

Municipal and Industrial Water

Browning gets its water supply relatively inexpensively from a large spring area in the Flat Iron Fork drainage west of town. This is accomplished through a system of collector lines, a collection gallery, and a gravity pipeline which transports the water under adequate pressure to the city's distribution system. Three water studies were made by consulting engineers in 1955, 1962, and 1967. These studies indicate that there is an adequate water supply in the spring for present and future needs and potential for expansion of the collection gallery. Shortages have been reported during the mid-winter months, but this seems to be due to a leaky and inadequate distribution system and uncontrolled use of the water. Although the supply is adequate, there is a need to expand the municipal water distribution system to meet the needs of new housing projects being developed.

Recreation

Recreational opportunities in the watershed and adjacent areas are ample to meet local needs. There is a need for overnight camping facilities to accommodate summer tourists.

Fish and Wildlife

Fishery habitat has been reduced in Willow Creek through Browning due to the channel modifications that have been made in this area in attempts to alleviate urban flooding problems. There are excellent fishing opportunities in the area. There are several excellent streams and lakes near the watershed, including the nationally recognized Duck Lake which produces many large trout.

Waterfowl habitat in the watershed is abundant. Because of the glacial terrain in the area, there are about 100 potholes which make good habitat for waterfowl.

Wildlife habitat is limited in the watershed. There are about 1,720 acres of timber, aspen, and brushy habitat.

There are no endangered species in the watershed.

Economic and Social

Economic and social problems in the watershed include unemployment, underemployment, low income levels, low education levels, potential loss of property tax base, poverty among a large segment of the population, and poor housing conditions. Per capita income is about one third of both the state and U. S. average.

Browning serves as the social and business center for the Blackfeet Indian Reservation. The reduction of flooding problems is essential for community improvement and improved environmental and health conditions of people in Browning.

PLATE 1

Photo by Don Schmidt

Flooding as shown in 1948 causes damages in a 20-block area in Browning.

Photo by Don Schmidt

PLATE 2

Photo by Don Schmidt

Floodwaters lapped on the west side of the bank in June 1964 and severely damaged a parking lot to the rear. Sand bags were common practice.

Photo by Don Schmidt

Floodwaters extended across the east side of Browning in June 1964. Trenches were cut through the highway in an attempt to reduce flooding.

Photo by Don Schmidt

Floodwaters spread filth, debris, and pollution as they move through the city June 1964.

Photo by Don Schmidt

Inventory losses and property damages were high during the flood of June 1964. City facilities, including streets and sewers, were also damaged.

PLATE 4

SCS Photo MT-P482-9

SCS Photo

Severe winters with high winds and drifting snow are common in Browning and the watershed area.

SCS Photo MT-P482-12

PLATE 5

BIA Photo

Warm chinook winds on heavy snow accumulations often produce flooding in Browning as shown here in January 1968.

BIA Photo

U. S. Highway 89 west of Browning is damaged nearly every year by high water from Willow Creek. Water over the highway causes foundation and shoulder damage.

SCS Photo March 1972

SCS Photo MT-P559-6

Floodwater builds up large impoundments and crosses U. S. Highway 89 three places between Willow Creek crossing and Browning.

County and private roads above Browning are also frequently damaged by floodwater. Water washes out culverts and damages road embankments.

SCS Photo March 1972

PLATE 7

Great Falls Tribune Photo

Flooding due to snowmelt in March 1972 covered a 4-block area in Browning. Floodwaters are contaminated by sewage and trash.

Great Falls Tribune Photo

Emergency channel enlargement on Willow Creek was undertaken in an effort to drain impounded water as shown above.

PLATE 8

Nine families were forced from their homes by the March 1972 flood. Larger floods are far more serious.

Great Falls Tribune Photo

Flood relief was provided by many local citizens and the Red Cross. Refugees were fed and housed in the Blackfeet Community Center.

Great Falls Tribune Photo March 1972

PLATE 9

SCS Photo ORC-225-9

The primary source of sediment production in the watershed is channel erosion caused mainly by flood flows.

SCS Photo MT-P417-8

PROJECTS OF OTHER AGENCIES

The Montana Highway Department has plans to widen and improve U. S. Highways 89 and 2 through Browning. This improvement is planned to extend to the highway junction about one-eighth mile west of Browning. Preliminary highway plans were reviewed during watershed investigations. It appears that some cost savings would be possible to the Montana Highway Department by using smaller culverts just west of Browning, if the watershed project could be implemented simultaneously or prior to highway construction.

New housing projects are being developed by the Bureau of Indian Affairs and the Blackfeet Tribal Council. These developments are outside the flood plain; however, there is a need to expand municipal water distribution to serve these homes. Local interests favor expanding the present supply system or developing additional ground water sources.

The Army Corps of Engineers prepared a preliminary proposal for flood protection at Browning in 1959. A potential channel and levee project was proposed. Due to insufficient local interest, this project was never developed.

The watershed area is tributary to Cut Bank Creek and hence to the Missouri River. No other water resource developments by city, county, state, or federal agencies are in existence or under development in or outside the watershed which have a direct relationship to this watershed project.

BASIS OF PROJECT FORMULATION

INTRODUCTION

An application for assistance under PL-566 was submitted by the sponsors and approved by the State Soil Conservation Committee on March 29, 1968.

Several special meetings have been held with the sponsors during preliminary and advanced planning stages to discuss various alternatives and get their responses and ideas. Other meetings have been held with specialists within the Soil Conservation Service. Input was requested and received from other concerned agencies and groups, including U. S. Bureau of Sport Fisheries and Wildlife; U. S. Forest Service; U. S. Army Corps of Engineers; U. S. Bureau of Indian Affairs; Blackfeet Tribal Business Council; Montana Highway Department; Christian, Spring, Sielbach and Associates; Wenzel and Company; and U. S. Public Health Service. In addition, a number of other interested agencies were furnished a copy of the preliminary investigation report and asked to comment.

Two public meetings were held--one for the presentation of the preliminary investigation report in July 1969 and one for the presentation of the draft work plan. Communications were maintained with the sponsors during the planning process.

This watershed project is identified as one of the principal water control features in the 1980 Framework Plan shown in the June 1969 Type 1 Comprehensive Framework Study for the Missouri River Basin.

PROJECT OBJECTIVES

The basic objective of the sponsors in their application for assistance is to reduce floodwater damages in Browning. Protection from the largest storm expected once in 100 years is considered adequate for this purpose. Another objective of the sponsors is to reduce streambank erosion taking place along lower reaches of Willow Creek.

Preservation and improvement of the existing fishery in Willow Creek and wildlife habitat in the watershed are also desired. Consideration was also given to the possibility of including water storage for municipal and industrial use and recreational use.

The work plan, in conjunction with the Management and Resource Plans of the Blackfeet Tribal Council and Bureau of Indian Affairs, is considered an adequate guideline for meeting project objectives and providing efficient use of land and water resources. Environmental considerations were given prime consideration in formulating project measures.

ALTERNATIVE PROJECT MEASURES

Land Treatment Only

Land treatment measures alone would maintain and improve the condition of the watershed, but would have little or no effect on present rate of runoff. Flood protection in Browning is basically a problem of keeping runoff from overtopping streambanks and flooding into low areas of the town. This alternative would not meet the objectives of the project.

Floodwater Channel and Dikes Only

A preliminary design was made and construction quantities were computed for a stable earth channel system through Browning to convey the floodwater runoff of Willow Creek. The estimated cost of installation, including land rights, is about $648,300. Land rights requirements include relocating numerous water, gas, sewer, and utility lines as well as new bridges and street sections and estimated at $223,500.

A second preliminary design replacing the earth channel through Browning with a concrete-lined channel was estimated to cost $670,300, including land rights. Land rights costs were estimated at $156,000. This alternative would meet project objectives of preventing flood damages, but would have several adverse environmental effects.

Floodwater Retarding Structures

A floodwater retarding structure was proposed on Willow Creek about four miles west and one mile south of Browning. This structure would control 57 percent of the drainage above Browning. Hydrologic analysis showed that the structure alone would not adequately protect Browning.

A second dam identified as the Goose Lake site was combined with the above Willow Creek site. This dam was located at an existing pond to control 3.35 square miles of drainage area tributary to Willow Creek. This controlled an extra 13 percent of the contributing area, but hydrologic analysis again showed that flooding in Browning was not reduced sufficiently to meet project objectives.

A third floodwater retarding structure identified as the Mission site was considered lower down on Willow Creek about 1.5 miles west of Browning. This structure alone would have controlled 87 percent of the drainage area above Browning. The estimated cost of this structure was $700,000. This high cost estimate was due to extensive foundation preparation required and a poor embankment-to-storage relationship. Some additional structural measures would still be required to fully meet the project objectives.

Dams on Willow Creek would prevent fish movement. The reservoirs would inundate some wildlife habitat. The sediment pools would provide additional fishery and waterfowl resting area.

Floodwater Diversion System

A floodwater diversion was considered. It consisted of a combination of channel and dikes to transfer water from the Willow Creek flood plain to the Flat Iron Fork of Willow Creek. This would control 92 percent of the drainage area. However, because Browning is in a low area on the flood plain, additional supplementary structural measures would be required to completely meet project objectives. These measures would have a minimum impact on fish and wildlife since normal flows would not be interrupted and little natural channel would be disturbed. However, diverting uncontrolled peak flows from the upper watershed into Flat Iron Fork could cause serious erosion and induce flood damages on that drainage. Total cost is estimated at $343,200. This system would not reduce floodwater damages on U. S. Highway 89 and other portions of the upper watershed. Although the diversion alone would have capacity to handle peak flows, it would be difficult to ensure that it would remain fully operable during the winter even with extensively planned snow and ice removal operations.

Flood Plain Insurance

Flood plain insurance could offset some flood losses. However, this would do nothing to stop pollutants, filth, and debris that now wash into the damage area. The large fixed investment already in the flood plain, including the city development of sewers, streets, and water systems, would be depreciated. The impacts to fish and wildlife would be negligible. Health and safety hazards to people would still prevail. This alternative was not considered to be acceptable.

Relocation

This alternative would cost in excess of $1,000,000 and was not considered to be feasible.

Flood Plain Management

Land use regulation within the "with-project" 100-year flood plain would be beneficial to help prevent and reduce future flood damages. A comprehensive plan should be adopted by Browning for these areas. Improvement of the environmental setting would result. This alternative, to be practical, must be considered in conjunction with structural flood prevention measures.

Install No Floodwater Protection

This alternative was considered invalid after favorable benefit to cost ratios were determined for other protection measures studied.

S E L E C T E D P R O J E C T M E A S U R E S

Land Treatment Measures

Land treatment measures have been selected to improve and maintain good cover conditions in the upper watershed. Measures such as proper grazing use, planned grazing systems, ponds, and related conservation measures are included.

Combination Floodwater Retarding Structure and Diversion System

A combination of structural measures was examined to better achieve project objectives and minimize adverse effects. The combination of the (upper) floodwater retarding structure on Willow Creek with a floodwater diversion system was determined to be the most practical. This combination provided floodwater protection to U. S. Highway 89 and farmers in the upper watershed. This combination also reduced peaks and the volume of water being transferred in the diversion to Flat Iron Fork by about 50 percent. The chances of serious erosion and induced flood damages on Flat Iron Fork would be minimal. This system would provide more reliable flood protection than the diversion system alone, especially from winter or early spring floods that result from warm chinook winds. The dam proposed in this combination would control flows from 57 percent of the area which contributes to flooding in Browning. This would be desirable especially during snowmelt events since it would allow more time for snow and ice removal and natural melting to occur to ensure operation of the diversion channel.

The dam and reservoir would restrict fish movement and inundate some wildlife habitat. The sediment pool would provide an additional fishery. The diversion is designed to have minimal effects on fish and wildlife. The reservoir will have stabilizing effects downstream on

Willow Creek, thereby lessening sediment and floodwater damages to fish habitat. The upper floodwater diversion will allow for uninterrupted passage of up to 150 cfs in Willow Creek. Since this capacity is far above normal flows, water rights for domestic uses and irrigation should not be affected.

A lower floodwater diversion, located just west of Browning, was added to the above combination in order to completely achieve the project objectives.

The combination of these structural measures is estimated to have an installation cost of $448,900.

The project will not require the relocation of any persons, farm operations, or businesses. The quality of environment for people will be improved by reducing flood damages, pollution, and filth associated with floodwater. The project will have some negative effects on fish through the loss of stream habitat and blocking of fish migrations. The increased flood peaks in Flat Iron Fork are not expected to damage property or be detrimental to land or wildlife resources in this drainage. The additional flooding that occurs on Flat Iron Fork will be limited to rangeland and bottom land on a generally wide flood plain. Some increase in vegetation along Flat Iron Fork is expected due to the irrigation effect of high water flows.

Flood plain management will be provided in conjunction with land treatment and structural measures for the area within the 100-year, "with-project" flood plain. A comprehensive plan for Browning will provide for urban renewal over time that would result in the flood proofing or removal of existing development that is within the "with-project" 100-year flood plain. Open space use such as parks or green areas will be considered for the areas not already built up or areas rehabilitated.

WORKS OF IMPROVEMENT TO BE INSTALLED

LAND TREATMENT

Land treatment measures planned for nonfederal land in the watershed are aimed at improving and maintaining good vegetative cover. Land treatment measures to be installed on rangeland include proper grazing use, planned grazing systems, ponds, and related conservation measures. Conservation plans will be developed to facilitate the installation of land treatment measures.

The estimated cost of land treatment measures, including technical assistance, is $4,100. See Table 1.

STRUCTURAL MEASURES

Willow Creek Floodwater Retarding Structure

The floodwater retarding structure on Willow Creek will be located in the SE¼ section 12 and NE¼ section 13, T32N, R12W, approximately four miles west and one mile south of Browning. This structure will consist of an earthfill dam, a principal spillway, and an earth emergency spillway. The structure is designed to control the maximum storm expected once in 100 years. The earth emergency spillway is expected to function less than once in 100 years. The reservoir will control runoff from 15.03 square miles or about 57 percent of the drainage area above Browning. Structure life is planned to be 100 years. See Figures 1 and 4 and Table 3. Also see Photo Plate 10 at the close of this chapter.

The principal spillway will consist of a reinforced concrete, modified, standard covered riser and a 30-inch diameter prestressed concrete steel cylinder type conduit located in the right abutment of the dam. The riser will be 14 feet high and be equipped with trash rack designed to meet watershed conditions. A 12-inch diameter welded steel pipe will be installed from the upstream toe of the dam to the riser. A gate valve will provide control of this pipe for emergency drawdown of the sediment pool or other operation and maintenance. The crest of the riser will be placed at elevation of the 50-year sediment pool. The conduit will be constructed with a reinforced concrete cradle, antiseep collars, and an impact outlet basin with rock riprap. The discharge through the conduit is 134 cubic feet per second (cfs) when the reservoir is at maximum stage.

The foundation of the dam will be excavated to dense shale bedrock and the principal spillway conduit will be placed upon an unyielding foundation.

The dam will be constructed of compacted earth fill. See Figure 1. A gravel chimney drain with a pipe outlet is planned in the downstream portion of the embankment. The total volume of the embankment, including foundation backfill, is estimated at 124,000 cubic yards. The dam will be 1,835 feet long, 40 feet high, with a top width of 16 feet. The upstream face is planned with a slope of 3 to 1 and protected with rock riprap from elevation 4,574.5 feet mean sea level (msl) to elevation 4,585.5 feet msl. This represents a vertical distance of six feet below the riser to five feet above the top. The downstream face of the dam is planned with a slope of 2 to 1 and a berm 10 feet wide at elevation 4,587 feet msl. Grass will be seeded on the non-riprapped slopes and top of the dam. The dam will have a vegetated emergency spillway located in the left abutment. The spillway will be 450 feet wide and have a 500-foot-long level crest section. The alignment will be straight and perpendicular to the control section for a distance of one-half of the maximum base width of the dam and then curve to the right. The discharge capacity will be 5,715 cfs. The reservoir will have a storage capacity of 847 acre-feet at the crest of the emergency spillway (4,603 feet msl) and will cover 68 surface acres.

The capacity of the reservoir includes 100-year sediment storage of 98 acre-feet at elevation 4,584.6 feet msl and 749 acre-feet of floodwater storage at elevation 4,603 feet msl.

Borrow materials will be obtained from excavation of the emergency spillway, the foundation excavation, and from portions of the reservoir area. All cuts will be graded, smoothed, and planted to grass to reclaim the disturbed areas and reduce erosion.

About 8.1 acres of brush will be cleared in the reservoir basin. About 0.6 miles of fence will be removed and rebuilt. About 2.4 miles of temporary fence will be constructed to protect the dam, spillway, and borrow area during seeding establishment. About 0.75 mile of electric power line and 0.5 mile of telephone line will be relocated. Old buildings will be cleared from the reservoir basin, including a small run-down house. This house has had conditional intermittent use as a summer cabin by a Browning resident.

The installation of the dam and reservoir will require the acquisition of 190 acres, including 96.9 acres of rangeland, 8.1 acres of brushy habitat, and 85 acres of valley bottom land. Of this, 23 acres are needed for the dam and spillway; 10 acres are needed for the 50-year sediment pool;

an additional 8 acres are needed for the 100-year sediment pool; and 50 acres are needed for flood storage above the sediment pools. The remaining 99 acres to be acquired will facilitate land rights acquisition along legal subdivision lines and be available for borrow material and construction activities. Land rights to be acquired include 15 acres of privately owned land and 175 acres of Trust Allotment land.

The estimated construction cost of this floodwater retarding structure is $155,500.

Upper Floodwater Diversion

The Upper Floodwater Diversion is planned to intercept peak flood runoff from the area of 9.43 square miles below the Willow Creek floodwater retarding structure and divert it from the Willow Creek drainage into the Flat Iron Fork of Willow Creek. The location of the diversion was selected at the only practical place where water could be collected and diverted from Willow Creek to Flat Iron Fork. This diversion will bypass a major portion of the floodwaters around Browning. See Figure 4, Project Map.

The first 3,100 feet of the diversion will extend from U. S. Highway 89 across the flood plain to Willow Creek and will consist of a channel and dike combination. This channel reach will have minimum sections with 100-foot and 60-foot bottom widths and 2 to 1 side slopes and will follow natural low areas. The dike will follow a line of low knolls parallel to the constructed channel and have a 10-foot top width with 3 to 1 side slopes. See Figure 2. The excavated sections will be through gravelly and gravelly clay soils. The excavated material will be used to construct the dike. Seeding of the bottom and side slopes of the channel and the dike is the only stabilization measure required.

A second reach, about 900 feet long, consists of the natural unaltered channel of Willow Creek. A small dike will be constructed at one low area so that flows will be contained down to the diversion structure on Willow Creek. This diversion structure will consist of an embankment with an upstream slope of 3 to 1 and a downstream slope of 2 to 1 and have a top width of 10 feet. The maximum height is 15 feet. Two ungated 30-inch-diameter reinforced concrete conduits capable of passing 150 cfs will be placed beneath the embankment to allow uninterrupted passage of normal flows in Willow Creek. The conduits will have a headwall at the inlet and a PWD basin at the outlet. The upstream slope of this diversion structure will be riprapped and the rest will be seeded to grass.

The third reach of the floodwater diversion channel is 4,700 feet long, goes from Willow Creek to Flat Iron Fork and consists of sections of excavated channel and small embankments. Excavated channel sections will be constructed from Willow Creek to a large glacial pothole and from the pothole into the Flat Iron Fork flood plain. Dikes are constructed from knoll to knoll along the channel and around the pothole to provide freeboard as required. A gated 18-inch-diameter pipe will be installed in the dike near the pothole to provide for a crossing of an existing irrigation facility. Design flows will be contained within the excavated sections except when crossing the pothole. The excavated sections for this reach are 100 feet wide with 2 to 1 side slopes. Excavation in this channel reach will be in glacial till consisting of gravelly clay. The fill sections will have a 10-foot-wide top with 3 to 1 side slopes. The outlet will consist of an excavated 800-foot section across the Flat Iron Fork flood plain on contour. This is designed to overflow onto the flood plain at an even depth with nonerosive velocities. A short reach of dike at the outlet will be riprapped and all other disturbed areas will be smoothed and seeded with grass.

Associated with this diversion system will be an enlargement of the culvert crossings on State Highway 464 about one-half mile north of Browning. The existing crossing will be replaced by four 83-inch by 53-inch oval, reinforced concrete pipes. Some channel shaping will be required at the inlet and outlet ends of the pipes.

This upper floodwater diversion system will not require enlargement or realignment of existing channels. This system, in conjunction with reductions provided by the Willow Creek floodwater retarding structure, will control the maximum storm expected once in 100 years from the drainage area above the diversion system. Hydrologic analysis was used to determine the 100-year design storm requirements. The channel sections are designed to have nonerosive velocities for maximum flow conditions. See Table 3A.

Land rights will require use easement or acquisition of 210 acres of pasture and rangeland. This includes 197.5 acres of privately owned land and 12.5 acres of Tribal Trust land. Actual construction of dikes and channels will cover 28 acres.

The estimated construction cost of the upper floodwater diversion is $87,300.

Lower Floodwater Diversion

The lower floodwater diversion is planned to intercept runoff from an area of 0.93 square miles south of U. S. Highway 89 and below the upper floodwater diversion west of the fairgrounds. See Figure 4, Project Map.

The first reach is 3,000 feet long. It extends from U. S. Highway 2 northwesterly to U. S. Highway 89 and the reach then continues north across the highway through the fairgrounds along the west side of the race track. This first reach consists of a dike built from borrow material taken from the upstream side. The borrow area will be a shaped channel with a gradient to drain runoff over to Willow Creek. See Figure 2 for typical section. Two new 76-inch by 48-inch oval, reinforced concrete pipes will be installed at the crossing on U. S. Highway 89. The dike will average about four feet high with a top width of ten feet and will have 3 to 1 side slopes. The borrow area will be excavated in glacial till, gravelly clay soils.

The second reach will be 3,800 feet long and will consist of a low dike, 2-3 feet high, paralleling Willow Creek from the fairgrounds to the bridge on Hospital Street. The dike will have a top width of 10 feet and 3 to 1 side slopes. No alteration of the Willow Creek channel is planned. The existing drain along West Boundary Street will outlet through this dike by means of a 60-inch-diameter conduit fitted with an automatic drainage gate. The flow gradient in this reach is such that no stabilization measures are needed.

Two short, low bank areas along Willow Creek channel below the Hospital Street will be diked to prevent the 100-year flood peak from overtopping the channel. One dike, about 100 feet long and one foot high, will be provided in the Indian agency grounds area. Small dikes on each side of Willow Creek, for about 300 feet above the East Boundary Street bridge, are also planned. This will prevent water from flowing south to low areas in Browning. The dike on the north side will be about 300 feet long, two feet high, and have a 10-foot top width and 3 to 1 side slopes.

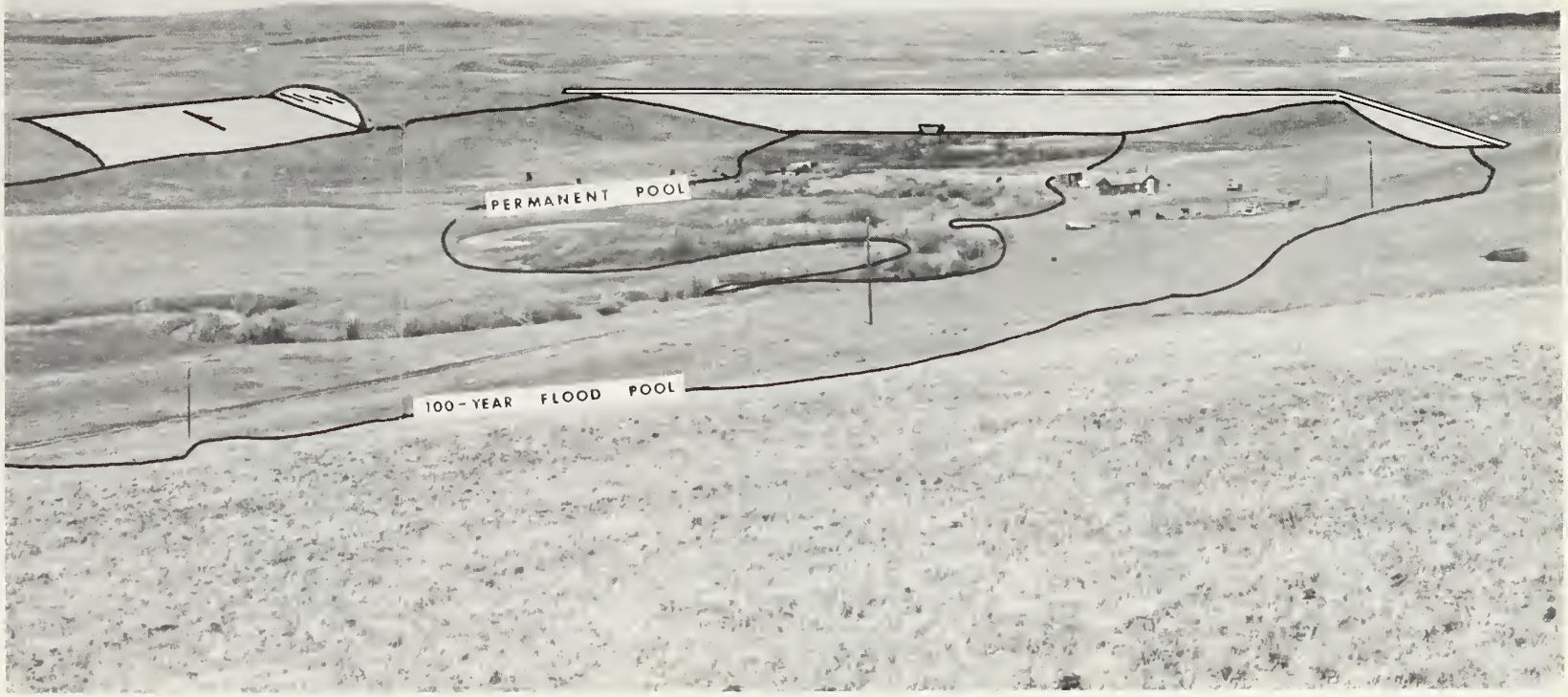
Protective measures for the lower floodwater diversion system will include seeding grass on all disturbed areas. Riprap and a concrete headwall will be provided at the West Boundary drainage gate outlet. The design capacity of the lower floodwater diversion is based on providing protection from the largest storm expected in 100 years in conjunction with planned upstream structural measures.

Land rights for the Lower Floodwater Diversion will require a culvert crossing on U. S. Highway 89 and easements or acquisition of about 27 acres of rangeland for locating the diversion system. This includes about 4.5 acres of privately owned land and 22.5 acres of Tribal Trust land. Actual construction of dikes and channels will cover 19 acres.

F L O O D P L A I N M A N A G E M E N T

Flood plain management will be provided by the sponsors in conjunction with structural and land treatment measures to reduce

damages for the area that is in the 100-year "with-project" flood plain. See Urban Flood Plain Map, Figure 3. Flood plain management will include the adoption of land use control measures such as zoning, building codes, land acquisition, and flood proofing to plan for optimum development. The adoption of flood plain management will become a part of the overall comprehensive plan for development in Browning.



SCS Photo ORC-225-12

Looking downstream to reservoir basin and floodwater retarding structure site on Willow Creek. This structure will control runoff from 57 percent of the contributing area in the watershed.

PLATE 10

EXPLANATION OF INSTALLATION COSTS

LAND TREATMENT MEASURES

Installation cost of land treatment measures as shown in Table 1 totals $4,100. This amount represents both application and technical assistance costs.

STRUCTURAL MEASURES

Total cost of structural measures include construction, engineering services, land rights, and project administration. All installation costs are allocated to flood prevention.

Construction

The total construction cost for the project is estimated at $264,500. The cost of the floodwater retarding structures includes clearing right-of-ways, foundation and emergency spillway excavation, construction of embankment and principal spillways, shaping and seeding of disturbed areas, and disposal of waste and spoil material. The construction cost of the floodwater diversions includes clearing of right-of-ways, construction of diversion dikes, diversion channel shaping, construction of water control structures, and shaping and seeding of disturbed areas. A contingency allowance of 15 percent is included to allow for unforeseen costs. See Tables 1 and 2.

Engineering Services

The cost of engineering services, estimated at $44,900, includes the direct cost of engineers and other technicians for surveys, investigations, design, and preparation of plans and specifications for structural measures, including associated vegetative work.

Project Administration

Project administration costs, estimated at $55,300, include contract administration, review of engineering plans prepared by others, government representatives, construction surveys, and all necessary inspections during construction that are required to ensure installation of structural measures in accord with plans and specifications.

Relocation Payments

The acquisition of lands required for the project will not necessitate the relocation of any person, farm, or business. The Willow Creek reservoir basin contains a small, old house used periodically during the summer. No relocation cost is foreseen.

Land Rights

The total land rights costs for the project are estimated at $84,200. This total amount includes relocating utilities, land purchases, flowage easements, and road and highway bridge crossings. Surveys, legal fees, etc., are estimated at seven percent of the land acquisition cost.

Land rights cost for the Willow Creek reservoir site is estimated at $16,500. This amount includes $10,600 for 190 acres of right-of-way or flood easement; $700 for land acquisition costs, including surveys; $3,800 to relocate 0.75 mile of power line; $800 to relocate 0.5 mile of telephone line; and $600 to relocate 0.6 mile of property fence.

Land rights cost for the Upper Floodwater Diversion System is estimated at $48,100. This amount includes $32,600 for highway culvert crossing; $5,000 for relocating 500 feet of natural gas line; $9,800 for land easements and right-of-way on 210 acres; and $700 for acquisition costs.

The cost of land rights for the Lower Floodwater Diversion is estimated at $19,600. This amount includes $15,700 for highway culvert crossing, $3,600 for land easements and right-of-way on 27 acres, and $300 for acquisition costs.

COST SHARING

Installation costs will be shared between the local sponsors and the federal government according to the requirements of Public Law 566 as amended and the Policy Statement of the Secretary of Agriculture. All construction and engineering service costs will be borne by Public Law 566 funds. Land rights costs will be borne by other funds.

Public Law 566 Funds

The following costs will be borne by Public Law 566 funds:

1. All the construction cost, estimated at $264,500.
2. All engineering service cost, estimated at $44,900.
3. Project administration cost, incurred by the Service, estimated at $54,700.

Other Funds

The following costs will be borne by other than Public Law 566 funds:

1. All land rights cost for land purchases, easements, rights-of-way, highway and road bridges, and utility relocations, estimated at $84,200.
2. Project administration cost incurred by the sponsors, estimated at $600.

EXPENDITURES BY FISCAL YEARS

The estimated expenditures of funds by fiscal years is shown in the table on the following page.

OBLIGATION OF FUNDS BY FISCAL YEARS

CITY OF BROWNING WATERSHED, MONTANA

	1st Year		2nd Year		3rd Year		4th Year		5th Year	
	PL-566	Other	PL-566	Other	PL-566	Other	PL-566	Other	PL-566	Other
Land Rights										
Willow Creek Floodwater Retarding Structure		16,500								
Upper Floodwater Diversion		10,500		37,600						
Lower Floodwater Diversion				3,900		15,700				
Construction										
Willow Creek Floodwater Retarding Structure			147,900		6,900				700	
Upper Floodwater Diversion					84,500				2,800	
Lower Floodwater Diversion							15,300		6,400	
Engineering Services										
Willow Creek Floodwater Retarding Structure	15,000		11,000		400					
Upper Floodwater Diversion			10,000		4,800					
Lower Floodwater Diversion					3,000		700			
Project Administration										
Construction Inspection			19,000		12,500		2,400		400	
Overhead	9,300		4,900		1,300		100		200	
Contract Administration	1,200	300	1,200	200	1,700	100	200		300	
Subtotal Project Administration	10,500	300	25,100	200	15,500	100	2,700		900	
Subtotal	25,500	27,600	194,000	41,700	115,100	15,800	18,700		10,800	
Land Treatment										
Rangeland		300		300		300		300		300
Technical Assistance		600		500		500		500		500
PROJECT TOTAL	25,500	28,200	194,000	42,500	115,100	16,600	18,700	800	10,800	800

EFFECTS OF WORKS OF IMPROVEMENT

The principal effects of installing the City of Browning Watershed project will be: (1) the reduction of floodwater damages to homes, businesses, streets, highways, and utilities in Browning; (2) the enhancement of opportunities for urban renewal and city development; and (3) the overall improvement of the environmental quality of the area.

Flood Prevention, Erosion and Sediment

The watershed project will reduce floodwater damages to Browning from the watershed area above the city. The runoff from 560 acres in and around the city will still cause some ponding of water in low areas in Browning. See Figure 3, Urban Flood Plain Map. Flood plain management over time is expected to minimize residual floodwater damages.

The urban area flooded by a 100-year storm will be reduced from 92 acres, including the whole city between "F" Street and the Willow Creek channel, to 10 acres of ponded water and minor flow in and along the low "D" and "E" Street areas. Maximum depths of flow in the urban area will be reduced from four feet to one foot. The 100-year peak flow, including both channel and flood plain flows, will be reduced from 1,850 cfs, most of which would now flow through the urban area, to 500 cfs, most of which would flow in the Willow Creek channel. The rural area flooded by the 100-year storm between the planned Lower Floodwater Diversion and the West Boundary Street of Browning will be reduced from 59 acres to 10 acres. Flooding around the museum and the fairgrounds will be reduced to minor ponding during a 100-year storm.

The urban area flooded by the 10-year storm will be reduced from 42 acres of major flooding with depths up to three feet to two acres of very minor ponding with depths less than one-half foot. The 10-year peak flow will be reduced from 620 cfs to 240 cfs. Flows will also be shifted from the urban area to the Willow Creek channel.

Damages for the 100-year storm would be reduced from $233,690 to $24,220. The June 1964 storm damages would have been reduced similarly. Damages for the 10-year storm would be reduced from $100,770 to $7,380. The damages for the 2-year storm, similar to the June 1970 storm, would be reduced from $23,040 to $1,310. These damage estimates are based on 1972 prices. Average annual damages over the life of the project which allow for increases in living standards would be reduced about 94 percent from $62,270 to $3,970. See Table 5.

More than 219 homes housing about 1,182 people and 64 businesses will be directly benefited by reducing floodwater flows. The value of private property benefited in Browning is estimated at 3.9 million dollars. The entire city of Browning, population 2,800, as well as other residents on the Blackfeet Indian Reservation, will benefit from this project.

Flows in Willow Creek at the highway crossing four miles west of Browning will be reduced from 1,300 cfs to 300 cfs during a 100-year storm. The present culvert crossing will handle this reduced flow and thereby reduce highway damages and traffic interruptions.

Floodwater diverted into the Flat Iron Fork of Willow Creek drainage will approximately double present peak flows. Peak flows during the 100-year storm would be increased from 420 cfs to 1,090 cfs. Peak flows during the 10-year storm would be increased from 170 cfs to 275 cfs. No flows would be diverted into Flat Iron Fork during a two-year storm. The increased flows will inundate an additional 7.1 acres of rangeland between the diversion outlet and State Highway 464 during a 100-year storm. The brief, infrequent, additional inundations are not expected to damage rangeland grass species. The diverted flows are not expected to create erosion in Flat Iron Fork. Tests indicate that the glacial materials can withstand the flows created by the 100-year storm. No flooding of dwellings or other structures will be induced by diverted floodwaters.

Land use in the agricultural flood plain is not expected to change from the present native hayland and pasture use. New growth in the urban area is taking place primarily outside the flood plain. Comprehensive city planning, which incorporates flood plain management of the 100-year, "with-project" flood plain, is expected to result in additional flood proofing and changes from developed use to open space use.

Streambank stabilization along Willow Creek within and below the watershed will result because of reduced peaks and flow volumes brought about by project measures. Land treatment measures will help maintain the already low sediment yields of the watershed.

Water quality in Willow Creek will be improved during flood events in and below the watershed as a result of the reduction of streambank erosion and the reduction of overland flow conditions which pick up debris and filth. The reservoir is expected to have an insignificant effect on water temperatures in Willow Creek since base flows are maintained by ground water recharge along the entire stream channel in the watershed.

Agricultural Water Management

This project is not designed to affect the drainage or irrigation on any lands. The proposed Willow Creek floodwater retarding structure will smooth out the peaks from high runoff events and extend flows in Willow Creek at higher than existing base flow rates for periods of one or two weeks. This may benefit downstream users. Irrigation water requirements below the project will still be satisfied by the 150 cfs capacity of the two ungated culverts under the Upper Floodwater Diversion on Willow Creek.

Dikes planned around the low edges of the pothole on the upper floodwater diversion, to contain the diverted flows, will also permit occasional storage of 60 acre-feet of water for irrigation. The existing irrigation diversion ditch from Flat Iron Fork to the pothole will not be interrupted. The pothole can be drained to its original level if no storage is desired.

Water Supply

The project is not planned to provide or affect the supply of municipal or industrial water.

Fish, Wildlife, Recreation

The dam on Willow Creek will cover five acres comprising 0.1 acres of streambank habitat and 4.9 acres of rangeland. The spillway requires 18 acres of rangeland.

The 50-year submerged sediment pool in the reservoir basin will permanently inundate 10 acres consisting of about 5 acres of valley bottom hayland, 4 acres of rangeland, and 1 acre of brushy streambank habitat in a 0.2 mile reach. This sediment pool will contain 39 acre-feet and have a maximum depth of 14 feet. This will create a pond for additional fish habitat.

The 100-year sediment pool will inundate an additional 8 acres, including 4 acres of valley bottom hayland, 2 acres of rangeland, and 2 acres of brushy habitat (0.2 mile of live stream channel).

The maximum flood pool will temporarily inundate 50 acres outside the sediment pool. This additional area consists of 5 acres of brushy stream area (0.3 mile of live stream channel), 23 acres of hayland, and 22 acres of rangeland.

Normal Willow Creek flows will be passed through the ungated principal spillway. The floodwater retarding structure on Willow Creek will prevent free interchange of fish populations in the stream. This loss is not expected to be significant due to the size and character of the stream.

The dam and sediment pools will inundate a total of 3.1 acres of brushy habitat which is 1 percent of the brushy habitat in the watershed. The temporary, infrequent inundation of 5 acres of brushy habitat between the 100-year sediment pool and maximum flood pool will affect an additional 1 percent of this brushy habitat in the watershed.

The Upper Floodwater Diversion will affect only a small portion of Willow Creek where the diversion fill crosses the channel. Two 30-inch ungated culverts will be placed in the channel bottom under this fill to allow passage of fish and normal Willow Creek flows.

A pothole included in the upper floodwater diversion channel alignment between Willow Creek and Flat Iron Fork will be filled periodically with an extra five feet of water. This would create additional waterfowl resting area. The pothole's surface would be increased from six acres to 18 acres.

The land rights to be acquired for the upper and lower floodwater diversion systems total 237 acres. This area includes about 190 acres outside construction areas to facilitate acquisition along legal subdivision lines. Channel construction will cover 33 acres and 14 acres will be used for dikes.

Disturbed areas for all structural measures will be seeded with grass.

Archeological, Historic, and Scientific

The project will provide flood protection for the Museum of the Plains Indians and the ceremonial grounds used by the Blackfeet Indian tribe just west of West Boundary Street.

An archeological survey conducted by the Montana Statewide Archeological Survey revealed the presence of a single tipi ring on the southeast abutment of the planned Willow Creek dam. The survey concluded that no antiquities would be affected by the project.

No properties in the watershed area are listed in the National Register of Historic Places.

Economic and Social

Improved community conditions resulting from this project are expected to strengthen overall area development. Most of the economic losses now being incurred by local residents from flood damages will be prevented. This reduction of damages will be particularly beneficial in helping to alleviate depressed economic conditions. Rural area development will be strengthened in providing a better community to service the entire Blackfeet Indian Reservation. The project will protect public investments already made in the flood plain area. Improved community conditions are also expected to help attract new basic industries to Browning, including expanded tourist facilities. Opportunities will also be provided for needed urban renewal measures. This will benefit all the people in Browning (2,800). This project will have a positive impact on the entire Blackfeet Indian tribe since Browning is their social center and about one-third of the Indians on the reservation live in the city.

Reduced flooding in Browning will improve environmental and health conditions. The project will help eliminate the spread of filth, debris, and contamination resulting from overland flows originating in the upper watershed.

A one-time capital outlay of construction funds in the form of wages will create an estimated 12 man-years of new employment during the construction period. Additional new employment equivalent to 19 man-years will be created within the local economy in the zone of secondary influence of the project.

The watershed project is also expected to produce local secondary benefits. There will be some increased economic activity induced by operation and maintenance activities.

Additional effects of the project will include some enhancement of property values in Browning. Cost savings in the form of reduced damages will accrue to several units of government.

Indirect damages resulting from flooding, including traffic detours, delays of residents and travelers, interruptions of utility and community services, and disruption of normal activities will be reduced.

PROJECT BENEFITS

PRIMARY BENEFITS

Average annual floodwater and sediment damage reduction benefits, over the life of the project, are estimated at $58,300. See Table 5.

Direct floodwater damage reduction benefits are estimated at $51,600 and include residential benefits of $37,960; commercial benefits of $10,450; and $3,190 of benefits to streets, highways, and bridges.

Indirect floodwater damage reduction benefits resulting from alleviating or preventing such conditions as traffic detours, disruption of normal community activities, and inoculations to prevent disease epidemics are estimated at $6,700.

SECONDARY BENEFITS

Local secondary benefits are estimated at 10 percent of the direct primary benefits that are a result of the watershed project, plus 10 percent of the increases in annual O&M costs. Secondary benefits are estimated at $5,460. See Table 6. Secondary benefits from a national viewpoint are not considered pertinent to this economic evaluation.

UNEVALUATED BENEFITS

Other benefits will accrue to the community in the form of improved environmental conditions, improved health and living conditions for people, increased opportunities for employment during construction phases of the project in an economically depressed area (redevelopment benefits), and increased interest in all aspects of soil and water conservation. The project will reduce erosion and downstream sediment deposition. These benefits are recognized, but not evaluated.

COMPARISON OF BENEFITS AND COSTS

Average annual benefits from structural measures are estimated at $63,760. Average annual costs of these structural measures are estimated at $33,870. See Table 6.

The ratio of average annual benefits to average annual costs is 1.9 to 1.0. The ratio of benefits to costs without the inclusion of $5,460 local secondary benefits is 1.7 to 1.0. Benefits and costs for structural measures are itemized in Tables 4, 5, and 6.

PROJECT INSTALLATION

Structural and land treatment measures will be installed during a 5-year installation period. Needed land treatment measures will be installed during this period to ensure optimum grass and crop use to hold erosion, runoff, and sediment production to a minimum. Engineering services and the acquisition of land rights will begin in the first year. Construction of the Willow Creek Floodwater Retarding Structure will be carried out during the second year. Construction of the Upper Floodwater Diversion will be started and completed during the third year. The Lower Floodwater Diversion will be built during the fourth year. Seeding and fencing of all structural measures will be done as soon as practical after construction or as conditions permit. Construction and inspection will be finalized during the fifth year.

INSTALLATION RESPONSIBILITIES

LAND TREATMENT MEASURES

Land treatment measures will be installed on private lands by individual landowners and operators. Technical assistance will be provided by the Glacier County Conservation District.

The responsibilities of the District will include:

1. Obtaining agreements from owners of not less than 50 percent of the land above the floodwater retarding reservoirs to carry out conservation measures and proper farm and ranch plans on their lands prior to the beginning of construction.

2. Providing leadership in the education program that will result in proper application of land treatment measures essential to the success of this project.

3. Encourage the development and use of conservation plans on all lands in the watershed to create a showplace of soil and water conservation.

FLOOD PLAIN MANAGEMENT

Flood plain management will be provided by the sponsors for the area of the "with-project" 100-year flood plain that is within Browning. See Urban Flood Plain Map, Figure 3.

STRUCTURAL MEASURES

The installation of all structural measures will be the responsibility of the City of Browning. The SCS has been requested to do the contracting. The City will be the Sponsor responsible for dealing with the SCS during construction. Federal assistance for installing the structural works of improvement as described in this plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666), as amended. Under this authority the Soil Conservation Service will provide: (1) engineering services including surveys, site investigations, design, and preparation of plans and specifications; and (2) project administration, including review of engineering plans prepared by others, government representatives, construction surveys, necessary inspection services during construction, and administration of construction contracts as requested by the local sponsors. The City of Browning will furnish local representatives to review plans and construction as necessary to assure local interests are met.

The Sponsoring Local Organization shall meet the following conditions for each portion of construction before issuance of invitations to bid on that unit of construction:

1. Land rights, including flood easements, will be assured by the City of Browning. The Sponsors have sufficient legal authority to acquire the needed land rights and agree to use such authority if necessary.

   The acquisition of all lands, easements, or rights-of-way shall be made in compliance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, PL-91-646, and appurtenant USDA and federal regulations. These provide that in cases where land rights are not obtained by donation or land exchange, every reasonable effort will be made to acquire real property rights by negotiation. Prior to the initiation of negotiations, an appraisal of the fair market value of the real property interest will be made by a qualified land appraiser.

2. Mutual agreement shall be reached on the schedule for construction and on plans and specifications. Terms of contracts and all matters pertaining to such contracts shall be mutually satisfactory and in accord with administrative and technical requirements governing the local sponsors and the Soil Conservation Service.

3. Full conformance with local, state, and federal laws shall be the responsibility of the local sponsors. Reasonable evidence of such conformity shall be provided to the mutual satisfaction of all parties at no expenditure of Public Law 566 funds.

METHODS OF INSTALLATION

The contracts for the construction of structural measures will be let on a competitive bid basis.

Contractors will be required to follow regulations to prevent sedimentation and pollution of stream waters during construction. Construction specifications will require that runoff from borrow and other disturbed areas be routed through sediment settling basins before going into the main channel. Contractors will also be required to install bridges or culverts where it is necessary to cross live stream channels with machinery. Provisions will be made to save topsoil material and spread it back over all areas to be reseeded. Dust control will also be required. All SCS safety requirements for construction will be strictly observed.

FINANCING PROJECT INSTALLATION

Project costs to be shared by Public Law 566 funds will be paid out of funds appropriated under the authority of Public Law 566, 83d Congress, 68 Stat. 666, as amended. This work plan does not constitute a financial document for obligation of either federal or other funds, including those of local sponsors. Financial or other assistance to be furnished by the Service in carrying out the plan is contingent on the appropriation of funds for this purpose.

The City of Browning is a legally constituted organization under Montana law. The City has the power to borrow money for financing the installation of this project, the power of eminent domain, and the power to levy taxes for repayment of borrowed funds and payment of operating expenses.

LAND TREATMENT

The cost of applying land treatment on private land will be borne by individual landowners or operators in conjunction with assistance as may be provided under ongoing agricultural programs. Technical assistance for land treatment will be provided by the Glacier County Conservation District in cooperation with the Soil Conservation Service from ongoing program funds available at the time of planning and installation.

STRUCTURAL MEASURES

Installation costs other than those allocated to Public Law 566 funds will be the responsibility of the City of Browning.

Local project costs are estimated at $84,800. However, through land trades and negotiations for easements and rights-of-way, local out-of-pocket costs may be less. The City of Browning plans to finance its share of costs through the sale of bonds to the Farmers Home Administration. Negotiations are under way with the State Director of Farmers Home Administration, including the filing of a preliminary application. At a current interest rate of 4.102 percent, FHA indicates that the annual finance costs for these bonds over a 20-year period would be $6,300, based on a principal sum of $84,800.

PROVISION FOR OPERATION, MAINTENANCE AND REPLACEMENT

LAND TREATMENT

Land treatment measures will be operated and maintained on private land by individual owners and operators in cooperation with the Glacier County Conservation District and Bureau of Indian Affairs.

STRUCTURAL MEASURES

The operation and maintenance of the floodwater retarding and diversion structures shall be the responsibility of the City of Browning in compliance with operation agreements satisfactory to the local sponsors and the Soil Conservation Service. An operation and maintenance agreement will be executed prior to signing of a Land Rights or Project Agreement in accordance with the Montana Watersheds Operation and Maintenance Handbook.

The operation of structural measures shall include, but not be limited to, the following:

1. Operating the Willow Creek structure as a floodwater retarding structure. Water will be stored at the 50-year sediment elevation and normal streamflows will be discharged through the principal spillway riser. Public use of the reservoir will be restricted until such time as adequate sanitary facilities are provided.

2. Operating the Upper and Lower Floodwater Diversions in a functional and efficient manner. The conduits in Willow Creek in the upper diversion dike are to be kept ungated to permit uninterrupted low flows.

The maintenance of structural measures shall include, but not be limited to:

1. Keeping all structures in serviceable condition by replacement and repair as needed during the life of the project.

2. Keeping all water control gates, conduits, culverts, and bridges clear of debris, drifted snow, and ice.

3. Maintaining protective vegetative cover, riprap, and fences as needed.

4. Keeping floodwater diversion channels clear of debris, snow drifts, and ice, especially prior to expected winter or early spring runoffs.

5. Keeping the emergency spillway of Willow Creek floodwater retarding structure free and clear of any restrictions at all times.

Operation and maintenance costs include items normally expected as repairs and upkeep on the structural measures. Annual operation and maintenance costs are estimated at $2,980.

A Service employee, responsible for operation and maintenance inspections and followup, and the local sponsors will make a joint inspection annually, after severe storms, and after the occurrence of any other unusual conditions that might adversely affect the structural measures. These inspections will continue annually for three years following installation of each structure. Inspections after the third year will be made annually by the local sponsors and a written report of conditions and recommended actions will be submitted to the Service employee responsible for seeing that operation and maintenance are carried out. In situations where the sponsors have shown lack of ability to carry out inspections properly, or there is an indication of need for continued Service assistance, the Service may continue to provide assistance after the third year at the discretion of the State Conservationist.

The Service employee responsible for operation and maintenance inspections and followup will thoroughly review the sponsors' inspection, operation, and maintenance reports. Evidence that inspections or needed maintenance are not being performed properly and promptly will be reported to the State Conservationist, who must then take appropriate action on reported deficiencies.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

City of Browning Watershed, Montana

Installation Cost Item	Unit	Non-Fed. Land	Estimated Cost (Dollars) 1/ Non-Federal Lands PL-566 Funds	Other Funds	Total
LAND TREATMENT					
Soil Conservation Service					
Rangeland	Ac.	20,000 2/		1,500	1,500
Technical Assistance				2,600	2,600
SCS Subtotal				4,100	4,100
STRUCTURAL MEASURES					
Construction					
Soil Conservation Service					
Willow Creek Floodwater Retarding Structure	No.	1	155,500		155,500
Upper Floodwater Diversion 3/	Ft.	10,400	87,300		87,300
Lower Floodwater Diversion 3/	Ft.	6,800	21,700		21,700
Subtotal Construction			264,500		264,500
Engineering Services					
Soil Conservation Service			44,900		44,900
Subtotal Engineering Services			44,900		44,900
Project Administration					
Soil Conservation Service					
Construction Inspection			34,300		34,300
Other - Overhead			15,800		15,800
Contract Administration			4,600	600	5,200
Subtotal Project Administration			54,700	600	55,300
Other Costs					
Land Rights				84,200	84,200
Subtotal Other Costs				84,200	84,200
TOTAL STRUCTURAL MEASURES			364,100	84,800	448,900
TOTAL PROJECT			364,100	88,900	453,000
SUMMARY					
Subtotal SCS			364,100	88,900	453,000
TOTAL PROJECT			364,100	88,900	453,000

1/ Price Base 1973

2/ Includes Continuing Practices.

3/ Channel Type 0

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

City of Browning Watershed, Montana

Measures	Unit	Applied To Date		Total Cost Dollars 1/
LAND TREATMENT				
Rangeland				
Conservation Plan	Nos.	4		1,400
Ponds	Nos.	1		875
Proper Grazing Use	Acres	20,000		1,200
Range Deferred Grazing	Acres	6,000		360
			TOTAL	3,835

September 1973

1/ Price Base 1973

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

City of Browning Watershed, Montana

(Dollars) [1]

Item	INSTALLATION COST: PL-566 FUNDS			INSTALLATION COST: OTHER FUNDS		
	Construction	Engineering	Total PL-566	Land Rights	Total Other	Total
Floodwater Retarding Structures						
Willow Creek	155,500	26,400	181,900	16,500[2]	16,500	198,400
Diversion Systems						
Upper Floodwater [5]	87,300	14,800	102,100	48,100[3]	48,100	150,200
Lower Floodwater [5]	21,700	3,700	25,400	19,600[4]	19,600	45,000
Subtotal	264,500	44,900	309,400	84,200	84,200	393,600
Project Administration	---	---	54,700	---	600	55,300
GRAND TOTAL	264,500	44,900	364,100	84,200	84,800	448,900

September 1973

1/ Price Base 1973

2/ Includes $10,600 for R/W (190 acres); $700 for R/W acquisition costs, including surveys; $3,800 to relocate 0.75 mile power line; $800 to relocate 0.5 mile telephone line; and $600 for 0.6 mile of fence.

3/ Includes $32,600 for highway culvert crossing; $5,000 for relocating 500 feet of natural gas line; $9,800 land easements and R/W (210 acres); $700 for surveys and R/W acquisition costs.

4/ Includes $15,700 for highway culvert crossing; $3,600 for R/W (27 acres); $300 for surveys and R/W acquisition costs.

5/ Channel Type 0

TABLE 3 - STRUCTURAL DATA

STRUCTURES WITH PLANNED STORAGE CAPACITY

City of Browning Watershed, Montana

ITEM	UNIT	WILLOW CR.
Class of Structure		C
Drainage Area (Total)	Sq. Mi.	15.03
Curve No. (1-day AMC II)		66
Elevation Top of Dam	Ft.	4,607.0
Elevation Crest Emergency Spillway	Ft.	4,603.0
Elevation Crest Principal Spillway	Ft.	4,580.5
Maximum Height of Dam	Ft.	40
Volume of Fill	Cu.Yd.	106,000 1/
Total Capacity	Ac.Ft.	847
Sediment Submerged	Ac.Ft.	78
Sediment Aerated	Ac.Ft.	20
Beneficial Use	Ac.Ft.	--
Retarding	Ac.Ft.	749
Surface Area		
Sediment Pool	Acres	10
Beneficial Use	Acres	--
Retarding Pool	Acres	68
Principal Spillway Design		
Runoff Volume (10-day)	In.	3.5
Capacity of Principal Spillway (Max.)	cfs.	134.2
Frequency operation-Emer. Spillway	% Chance	1
Diameter of Principal Spillway Barrel	In.	30
Emergency Spillway Design		
Rainfall Volume (ESH) (areal)	In.	4.22
Runoff Volume (ESH)	In.	1.22
Storm Duration	Hrs.	6.5
Type		Vegetated Earth
Bottom Width	Ft.	450
Velocity of Flow (Ve) (Max.)	Ft./Sec.	2.73
Slope of Exit Channel	Ft./Ft.	0.04
Max. Res. Water Surface Elevation	Ft.	4,603.9
Freeboard Design		
Rainfall Volume (FH) (areal)	In.	9.11
Runoff Volume (FH)	In.	4.94
Storm Duration	Hrs.	6.5
Max. Res. Water Surface Elevation	Ft.	4,607.0
Capacity Equivalents		
Sediment Volume	In.	0.12"
Retarding Volume	In.	0.93"
Beneficial Volume	In.	--

1/ Does not include core trench.

September 1973

TABLE 3A-STRUCTURAL DATA

CHANNELS

City of Browning Watershed, Montana

Upper Floodwater Diversion 6/								Lower Floodwater Diversion 6/					
			n = 0.04 (Aged)		n = 0.025 (As Built)						n = 0.04 (Aged and As Built)		
Station	Bottom Width (ft.)	Capacity (c.f.s.)	Water Surface Elevation 1/	Velocity (f.p.s.)	Water Surface Elevation 1/	Velocity (f.p.s.)	Top Elevation of Dike 1/	Station	Bottom Width (ft.)	Capacity (c.f.s.)	Water Surface Elevation 1/	Velocity (f.p.s.)	Top Elevation of Dike 1/
97+00	100	1160	399.50	1.94	398.50	2.42		68+00	NA 5/	430	374.1	3.08	375.0
92+75	100	1160	399.75	1.87	398.61	2.60	402.0	63+50	NA 5/	430	375.5	2.97	376.8
91+00	100	1160	399.86	2.01	398.67	2.71	402.0	62+00	NA 5/	430	376.1	2.09	377.4
88+00	100	1160	400.01	2.02	398.78	2.85	402.0	57+00	NA 5/	430	377.5	1.34	379.4
83+00	100	1160	400.22	1.48	399.01	2.01	402.0	53+50	NA 5/	430	379.1	4.22	380.8
78+00	100	1160	400.43	2.36	399.15	3.47		46+00	NA 5/	430	380.7	2.92	383.0
73+00	100	1160	400.80	2.48	399.56	3.57	402.5	45+50	NA 5/	430	380.9	0.31	383.0
68+00	100	1160	401.07	0.15	399.98	0.18	402.5	45+00	NA 5/	430	381.0	1.30	383.0
63+00	100	1160	401.07	0.21	399.98	0.24	402.5	43+00	NA 5/	315	381.8	1.66	383.0
58+00	100	1160	401.10	1.13	399.99	1.60	402.5	32+00	NA 5/	315	388.7	2.20	390.6
53+00	100	1160	401.33	1.83	400.25	3.18	402.5	29+00	NA 5/	300	390.3	0.68	392.0
48+00	100	1160	401.69	2.55	400.74	3.36	402.5	28+00	NA 5/	300	390.31	0.37	392.0
45+00	100	1160	401.93	2.60	400.97	3.45	403.0	27+00	NA 5/	300	390.31	0.29	392.0
43+00	100	1160	402.11	1.75	401.18	2.30	403.0	26+00	NA 5/	300	390.31	0.27	392.0
42+50	100	1160	402.13	1.77	401.19	2.33	410.0	24+00	NA 5/	300	390.32	0.28	392.0
38+50	2/	1310	404.86	13.48	404.59	14.28	410.0	22+00	NA 5/	300	390.32	0.28	392.0
38+40	3/	1310	407.70	2.40	407.83	2.27	410.0	20+00	NA 5/	300	390.34	0.45	392.0
31+20	4/	1310	408.48	2.03	408.49	2.02	410.0	18+00	NA 5/	300	390.37	0.55	392.0
29+50	60	730	408.63	0.60	408.61	0.60	410.0	17+00	NA 5/	300	391.77	2.85	392.0
25+50	60	730	408.71	2.10	408.59	2.15	411.0	15+00	NA 5/	300	394.2	2.85	397.4
19+50	60	730	409.11	1.70	408.79	1.99	411.0	1+00	NA 5/	300	397.2	2.85	400.2
14+50	100	730	409.41	0.68	408.97	0.78	411.0	0+00	NA 5/	300	397.4	0.00	401.0
9+50	100	730	409.49	1.53	408.98	1.74	411.0						
4+50	100	730	409.67	1.65	409.07	1.96	411.5						
2+50	100	730	409.71	0.69	409.14	0.87	411.5						
0+50	100	730	409.77	0.53	409.16	0.65	411.5						

1/ Represents elevation above 4,000 feet msl.
2/ Bridge section
3/ Natural cross section of creek
4/ Junction of channel with creek
5/ This diversion is principally a dike. The channel is shaped borrow area and incidental to construction.
6/ Channel Type 0

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TABLE 4 - ANNUAL COST

City of Browning Watershed, Montana

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Floodwater Retarding Structures and Floodwater Diversion Structures	27,100	2,960	30,060
Project Administration	3,810	---	3,810
GRAND TOTAL	30,910	2,960	33,870

September 1973

1/ Price Base 1973

2/ 100 years, 6-7/8 percent

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

City of Browning Watershed, Montana

(Dollars) 1/

Item	Estimated Average Annual Damages		Damage Reduction Benefit
	Without Project	With Project	
Floodwater and Sediment			
Non-Agricultural			
Residential	38,600	640	37,960
Commercial	11,980	1,530	10,450
Highways, Streets, and Bridges	4,530	1,340	3,190
Subtotal	55,110	3,510	51,600
Indirect	7,160	460	6,700
Total	62,270	3,970	58,300

September 1973

1/ Price Base 1973

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

City of Browning Watershed, Montana

(Dollars)

	AVERAGE ANNUAL BENEFITS 1/			Average 2/ Annual Cost	Benefit:Cost Ratio
	Damage Reduction	Secondary	Total		
Floodwater Retarding and Diversion Structures	58,300	5,460	63,760	30,060	2.1 to 1.0
Project Administration				3,810	
GRAND TOTAL	58,300	5,460	63,760	33,870	1.9 to 1.0

September 1973

1/ Price Base 1973
2/ From Table 4

GEOLOGY

METHODS AND SCOPE OF INVESTIGATIONS

Geologic investigations were conducted for each of the potential structure sites considered in the formulation of this watershed work plan. Available geologic maps and reports were reviewed. Field examinations of surface features were conducted. Preliminary auger borings were used to evaluate subsurface conditions at selected sites.

Floodwater Retarding Structures

Subsurface investigations of proposed dam sites and borrow areas consisted of borings by a B-40 mobile drill and backhoe pits. Borings extended to bedrock where possible and were visually logged. All materials were field classified according to the Unified Classification System. Borings were located along proposed centerlines of the dams and along the principal spillway locations. Geologic cross sections along dam centerlines were prepared.

Borrow areas were investigated with borings and backhoe pits. Representative samples from these areas were classified and evaluated by laboratory tests and included Standard Proctor Density Tests. Potential borrow areas were outlined.

Geologic investigations for proposed floodwater diversion channels consisted of surface investigations supplemented by correlation of nearby subsurface borings and observation of natural cuts and gravel pits.

Investigation of a proposed dam site on Goose Lake included eight subsurface borings. These borings indicated that the foundation conditions and borrow materials were suitable.

Two floodwater retarding structure sites on Willow Creek were investigated. The lower site (Mission) was located about 1.5 miles west of Browning. A total of 19 subsurface borings were drilled along the proposed centerline. The centerline for this dam was 4,100 feet long. The embankment of a dam at this location would be founded on a section of flood plain containing springs that issue from an apparent fault scarp. Borings disclosed the presence of artesian water pressures in the foundation materials. Extensive foundation treatment would be required to correct these hazardous conditions. Because of adverse geologic conditions and resulting high costs, this dam site was rejected in formulating the watershed work plan.

The upper dam site on Willow Creek, which was selected, is located about four miles west and one mile south of Browning. Eleven subsurface borings were drilled along the centerline of the dam. This site will be founded on consolidated gravelly clay, silty clay and gravel underlain by preconsolidated shales. The abutment areas consist of shales overlain by preconsolidated glacial till. Little consolidation is expected under the planned embankment loading. Seepage through the foundation and abutment areas can be controlled by a cutoff trench that will range from 5 to 15 feet in depth. The principal spillway can be located on unyielding bedrock.

The emergency spillway of the selected Willow Creek dam site will be located along the left abutment. The spillway will be cut in clayey glacial till (CL). The materials in the spillway are considered moderately erosive. The control section of this spillway will be 500 feet long. This is considered adequate to resist breaching in these soils during the passage of the freeboard hydrograph.

Impervious borrow materials are available adjacent to the planned Willow Creek site. Borrow areas were selected to utilize glacial soils above reservoir elevations. These materials were classified as gravelly clays and silty clays logged as CL-1 soils. Standard Proctor Tests of similar soils indicate dry weights of 102 to 110 pounds per cubic foot with an optimum moisture content of 14 to 18 percent.

Floodwater Diversions

Investigations for the floodwater diversions were completed by surface and limited subsurface investigations. Exposures in gravel pits, ditch sections, and reaches of Willow Creek were also evaluated. These investigations indicate that the dikes and channels in the Willow Creek flood plain will be founded on stable, consolidated, clayey gravel. The cut sections will be stable with planned 2 to 1 slopes. These materials should withstand short frequency flow velocities of six feet per second.

Excavation through the ridge forming the north boundary of the Willow Creek valley for the upper diversion channel will require cuts ranging from 4 to 10 feet. The ridge is a glacial deposition feature. A number of borings were completed in an adjacent upstream area. These borings indicate 7 to 12 feet of consolidated glacial till over shale bedrock. Surface exposures, general geologic history, and aerial photos indicate that the materials along the diversion channel centerline are similar in origin and composition to the adjacent upstream area where the borings were made. The glacial till material in this ridge is primarily gravelly clay (classified as CL-1 and CL-2). Although these clays are preconsolidated, they are considered moderately erosive. Review of ditch cuts indicates that they are stable on 1½:1 to 2:1 slopes and will withstand flow velocities of five to six feet per second.

The shale bedrock under the till on the ridge is moderately hard and massive. The shale is considered erosion resistant and will sustain low duration flow velocities of six to ten feet per second without appreciable erosion. The shale bedrock will be encountered in isolated reaches, but it will not constitute a construction problem.

The outlet end of the diversion along the Flat Iron Fork flood plain will be excavated in coarse cobble and gravel materials (D_{75}=3"), classified as GP or GW. Observations made in nearby gravel pits indicate that the diversion outlet area is covered by a minimum of 8 to 10 feet of these coarse materials. The gravels would withstand flow velocities of 10 feet per second or more without excessive erosion. Flood flows discharged into the Flat Iron Fork drainage should not affect present channel characteristics. This drainage is very wide and relatively flat.

Additional Investigation Needed For Construction

Additional subsurface investigations are needed in the foundation and abutment areas of the Willow Creek site to fully evaluate the bedrock for stability and permeability. Three or more holes 50 to 100 feet deep are needed at the dam site. Foundation drilling would include disturbed and undisturbed sampling, standard penetration strength evaluation, rock coring, and pressure testing. A series of drill holes or backhoe pits will be required to grid and evaluate the composition and quantity of borrow materials available for construction of the embankment.

A number of drill holes or backhoe pits will be needed to fully define the geologic conditions along the diversion channel centerline. Seepage rates and erosion potential will need to be evaluated.

SEDIMENT INVESTIGATIONS

Sediment and erosion rates were determined from a field reconnaissance study, use of aerial photos, and a review of available soil survey data. This study indicates that sheet erosion is the primary source of sediment yield in the upper watershed area. Little gully or streambank erosion was observed except in the vicinity of Browning. The amount of sheet erosion was determined by computations based on a modified Musgrave formula which employs factors of slope, land use, soil erodibility, and maximum 30-minute, two-year frequency precipitation.

The area above the Willow Creek site is primarily native rangeland. The sediment yield is about 0.10 acre-foot per square mile per year. Most of the needed land treatment measures have been installed; therefore, present and future rates of erosion and sedimentation are considered about equal.

Detailed pond surveys were not conducted in the watershed because of the low sediment rate. At the dam site, 98 acre-feet were allotted for 100-year sediment storage. The sediment pool is planned to be wet and a unit weight of 60 pounds per cubic foot of sediment was used. This figure was based on samples from ponds of similar sediment character. Trap efficiencies and delivery rates were calculated by using standard SCS methods.

H Y D R O L O G Y

Basic procedures used in hydrologic investigations are outlined and described in the National Engineering Handbook, Section 4, "Hydrology," and comply with the criteria in engineering memoranda.

Hydrologic studies were primarily concerned with (1) determining flood levels for various frequency storms in the city of Browning; (2) determining the effects of various combinations of proposed structural measures and land treatment measures on flood peaks, flood levels, and runoff volumes; and (3) computing and routing design hydrographs to size the floodwater retarding structures and their spillways.

BASIC DATA AVAILABLE

Precipitation and temperature data are available from the U. S. National Weather Service records for the climatological station at Browning, Montana, from 1934 to the present.

Surface water data from gaging stations are not available in the watershed; however, four crest-stage gages and ten water-stage recorder stations in the general area provided water yield and peak flow data which represented conditions in the watershed. These data are gathered and published by the U. S. Geological Survey. Drainage areas for the fourteen gaging stations selected vary from 3.47 square miles to 2,724 square miles. These stations have periods of record starting as early as 1902 to as late as 1962.

Soil and cover data available include soil survey maps compiled by the Bureau of Indian Affairs correlated by Soil Conservation Service soil scientists. Cover conditions were determined in the field by SCS personnel.

Topographic data available during early planning stages originally included Army Map Service 1:250,000 topography maps and 2.0 inches to the mile ASCS 1966 stereo photography. Later advance proofs of USGS 7.5 minute quadrangles became available and were used.

Local flood data included good photos of flooding in the city of Browning for the years 1948, 1964, 1967, 1968, and 1972.

INVESTIGATIONS AND ANALYSES

Historical Peak Flow and Annual Yield Frequency Studies

Peak flow studies were made to check results of the Hydrology TR #20 evaluation. Annual yield frequency studies were made to determine the runoff available in the watershed for possible municipal water supply.

Annual peak flow-frequency relationships using the Log Pearson III methods were developed for the three crest-stage stations selected and the ten water-stage stations. Peak flow values for the 1964 storm were considered as outliers for these records and were omitted in the frequency analyses. A plot of the drainage areas versus csm rates for different frequencies was used to check the TR #20 computer program results.

Annual yield-frequency relationships were developed from the ten water-stage station records selected to determine reliability of a water supply for possible municipal or recreational use. Yield for an eighty percent chance was estimated to be 4.5 inches.

Drainage Areas, Times of Concentration, and Runoff Curve Numbers

Drainage areas were originally planimetered from areas delineated on aerial photographs. Channel and flood plain distances were also measured on these photos. Data were refined using 7.5 minute advance proofs of the U. S. Geological Survey.

Times of concentration (Tc) were computed using the new maps. The Upland method was used for computing times of concentration on all the uncontrolled subareas and the Curve Number Method was used for the various dam sites investigated. Runoff curve numbers were based on weighted averages of the soil-cover condition for each area and subarea.

The original drainage areas and times of concentration taken from the photographs were used in the TR #20 computer program evaluation of the Willow Creek and Goose Lake floodwater retarding structures proposed in the preliminary investigation. Although the areas and Tc's were changed slightly in the final analysis, the results of this run were used to evaluate the effects of this proposal. Revised drainage areas and Tc values were used in the Mission dam proposal and in the final formulation of the Willow Creek dam and the two floodwater diversions.

Flood Routings

Water surface profiles were computed for the Willow Creek flood plain using surveyed cross sections at selected intervals starting about five miles above Browning to about one-half mile below Browning. Since the Willow Creek channel bottom was higher than the flood plain in some areas, a second water surface profile was developed for the Willow Creek channel only to determine its capacity. Water surface profiles were also computed on the Flat Iron Fork of Willow Creek from the upper floodwater diversion outlet to below State Highway 464 to check effects of diverted flows on water levels in this drainage. These computations were made using the FW-HD1-1130F WSP computer program.

Water surface profile computations were also used in the design and evaluation of the two floodwater diversions. These computations were done on the local computer terminal.

The Hydrology TR #20 computer program was used to model the watershed. Existing flooding conditions for 2-, 10-, 25-, and 100-year 24-hour storms were determined and effects were evaluated for various combinations of proposed structural measures and land treatment measures.

The results of these evaluations are as follows:

1. Present condition csm rates compared well with the regional analysis of stream gage records.

2. Flood levels obtained for existing conditions compared well with historical data and photographs of local flooding. Area flooded maps were plotted for the various storms.

3. The original proposal of the Willow Creek and Goose Lake floodwater retarding structures would not significantly reduce flood peaks because of the remaining large uncontrolled drainage area. However, they would reduce flood volumes and duration.

4. The proposed Mission reservoir site located only one and one-half miles above Browning was very effective in reducing flood peaks. Evaluation of this site was partially conducted with the local computer terminal.

5. The final proposal of an upper floodwater diversion structure located about one mile above Browning to intercept and carry flood waters north into Flat Iron Fork of Willow Creek was found to reduce flooding in Browning significantly. The TR #20 computer program indicated that the inclusion of the Willow Creek floodwater retarding structure will reduce peaks and volumes of flow transferred to Flat Iron Fork approximately 50 percent.

6. The TR #20 computer program indicated that the remaining area below the upper floodwater diversion could still produce flooding in Browning. This was due primarily to the fact that some areas in the town are very low. For this reason, a lower floodwater diversion located just west of town to direct flows into the Willow Creek channel was also included.

7. The existing Flat Iron Fork flows will be doubled with the installation of the proposed diversion works and the

Willow Creek structure; however, the evaluation shows that these flows will not create any damage to the existing limited development in that flood plain. The Flat Iron Fork of Willow Creek is wide, flat, covered with good grass vegetation, and will convey the diverted flows safely. It eventually flows back into Willow Creek approximately seven miles below Browning after going through many flat areas. Additional capacity will be provided on the existing Flat Iron Fork crossing under State Highway 464.

Design Hydrographs

The design hydrographs for the various floodwater retarding structures evaluated were developed using procedures in Chapter 21, Section 4, of the National Engineering Handbook, and routed using methods in Chapter 17 with use of the local computer terminal. Criteria in Engineering Memorandum 27 (Revised) were followed. Class "C" designation was applied to the structures at the direction of the State Conservation Engineer. The drawdown requirement was considered met when 80 percent of the maximum flood volume was released in ten days. A maximum head of four feet was allowed on the earth spillways during the passage of the freeboard hydrographs.

The principal spillway hydrographs were developed using the 10-day 100-year runoff amount of 3.5 inches as shown on Exhibit 21-4, Chapter 21, of the Hydrology Handbook.

Average antecedent moisture conditions were assumed for computing runoff for the emergency and freeboard hydrographs. Curve numbers are expected to remain unchanged during the project period.

Structure Sizing

The Willow Creek floodwater retarding structure chosen as a part of the final plan is on a drainage area of 15.03 square miles with a time of concentration of 6.5 hours. A curve number of 66 was used for this area for present and future conditions. The principal spillway crest was set at the 50-year submerged sediment pool level. Principal spillway releases will be controlled by the 30-inch diameter outlet barrel. An earth emergency spillway, 450 feet wide with a 500-foot level section, was located in the left abutment. The spillway leads into a natural grassed waterway which runs back into Willow Creek well below the dam. The maximum head on the emergency spillway is four feet, producing an exit velocity of 9.2 feet per second. An exit velocity-duration curve was developed for the geologic evaluation. This emergency spillway will meet bulk length requirements for erodible soils as specified in Technical Release No. 52.

E N G I N E E R I N G

SURVEYS AND INVESTIGATIONS

Topographic data for structural measures and cross sections were obtained from engineering field surveys conducted by SCS personnel. Vertical control for surveys was based upon mean sea level datum. The surveys were made with sufficient detail to design and locate structures and to compute necessary quantities.

The selection and design of structural measures also included the use of hydrologic data developed for the watershed. The results of these data were used to: (1) determine heights of dams, (2) size diversion dikes and channels, (3) establish capacities of the principal spillways, and (4) analyze effects of structural measures.

The results of geologic investigations were used as a basis for design of all structural measures. Use of these data included selection and determination of the following: embankment slopes of dams, foundation excavation quantities, channel sections and side slopes, borrow material locations, and sites for structural measures.

Floodwater Retarding Structure

The design and proportions of the floodwater retarding structure planned on Willow Creek were determined by consultation with Regional SCS soil mechanics specialists, SCS State design staff, and other SCS specialists. It was determined that an upstream slope of 3 to 1 with a berm 10 feet wide at the elevation of the top of the principal spillway riser and a downstream slope of 2 to 1 with a berm 10 feet wide at the midpoint would be adequate. See Figure 1. It was also determined that the embankment would require internal drainage and a chimney drain was selected as being the most practical. The upstream slope will be protected by a blanket of rock 18 inches thick laid on a gravel base six inches thick from an elevation six feet below to five feet above the elevation of the top of the riser. These determinations were based on standard wave protection criteria of the SCS. Hard angular rock is available from a quarry 35 miles west of Browning. This appears to be the most practical source.

The foundation preparation will consist of stripping to a depth of two feet and a cutoff trench extending to shale bedrock. No special foundation preparation problems are anticipated except for diverting streamflows during construction.

The principal spillway will be located in dense shale bedrock. This spillway was designed according to criteria of Engineering

Memorandum No. 27 (Revised). The drop inlet spillway will be a modified standard covered riser. This design incorporates an adequate trash rack for watershed conditions. A 30-inch principal spillway barrel meeting AWWA-301 specifications will be placed on a standard A-1 cradle. The barrel will have antiseep collars and an impact basin.

Borrow area investigations indicate most of the material can be obtained from the emergency spillway excavation and areas above the maximum reservoir elevation. Criteria of Technical Release No. 52 were used to plan the emergency spillway to ensure adequate bulk length for erodible soils.

Floodwater Diversions

The design of the upper and lower floodwater diversion systems was within the criteria specified in TR-25. A minimum freeboard of 1.3 times the design flow depth was maintained. Depths and velocities for design flows were computed using water surface profile computations. Manning's "n" value of 0.04 was used to establish maximum flow depths. An "n" value of 0.025 was used to determine maximum velocities. See data in Table 3A. Geologic and soils information indicated that slopes in cut and fill sections of 2 to 1 would be stable. The slopes for fill sections were made 3 to 1 to facilitate the establishment of grass cover. This will further ensure nonerosive conditions during peak flows for the upstream slopes.

The diversion structure across Willow Creek was planned using standard engineering criteria for small dams. Riprap is planned for the structure on Willow Creek and at the upper diversion outlet where high flow velocities are expected to occur. The outlet for the upper floodwater diversion consists of an excavated level extension of the diversion channel across Flat Iron Fork flood plain. This will allow for a smooth entrance of flows at uniform depths onto the Flat Iron Fork drainage.

Flows on Flat Iron Fork will not produce velocities greater than 10 feet per second. Soils analysis of the materials in this area indicates a D_{75} size of three inches which are estimated to withstand velocities up to 10 feet per second without erosion.

E C O N O M I C S

FLOOD PREVENTION

Economic investigation and analysis of the City of Browning Watershed concentrated on flood prevention. The following section describes the steps and methods of analysis used in determining the economic feasibility of the project.

Flood Damage and Benefit Analysis

The newspaper morgue was examined for records of past floods. Very little factual data were available for floods occurring prior to 1964. Some information was available for the 1964 flood; however, since the storm encompassed a wide area of Montana, most accounts and records of damages included areas outside Browning.

Some data pertaining to damages in Browning from the 1964 flood were available from the Army Corps of Engineers. The Corps conducted a partial survey of damages following this storm that included both residential and commercial properties.

Local residents and property owners were interviewed in 1969 by SCS personnel regarding damages sustained in the 1964 flood. These interviews pertained to property damaged other than that surveyed by the Corps. Damage reports correlated well with the Corps data and were used jointly in estimating depth-damage factors. These interviews also provided a basis for determining the areas of Browning which were flooded during the 1964 storm.

Depth-damage factors were developed for this project using regression analysis. Separate residential and commercial depth-damage curves were developed. These curves correlated well with the Stanford Research Institute data.

Damages to residential and commercial properties in the flood plain were estimated using the evaluation storms and specific data pertaining to each property. These evaluation storms were synthetically developed using hydrologic water surface profile data combined with the results of the TR-20 computer program. Flooding conditions for the 2-, 10-, 25-, and 100-year storms were simulated. Water depths for flood plain cross sections were determined for each of the evaluation storms. Elevations were established by engineering surveys. These elevations were used as a basis for estimating first floor elevations of buildings. First floor elevations were compared to the floodwater elevation to determine flooding depths. Property values were estimated from assessed values and the use of assessment to sale ratios. Flooding depths combined with property values and depth-damage factors provided the basis for estimating total flood damages for particular storms.

A damage frequency curve was developed for both with and without project conditions as a means to estimate average annual floodwater damage reduction benefits. Damage estimates for the 100-, 10-, and 2-year frequency storms were developed.

Interviews were also conducted with ranchers in the watershed above Browning. Average annual damages to agricultural lands were determined to be very low and were unevaluated. Minor fence damage was reported following the 1964 flood; however, very little land or crop damage occurred since the land in the flood plain is pasture and hayland.

Damages to highways, as well as streets in Browning, were considered in the development of floodwater damage reduction benefits. Historical data were used to assess damages and develop estimates of benefits accruing from the project.

Flooding from the 1964 storm at Browning was estimated to be similar in magnitude to the 100-year evaluation storm. The estimated total damage that occurred in Browning as a result of the 1964 flood was comparable to the computed damage for a 100-year evaluation storm without the project.

Damages in the future from any given storm are expected to be higher than damages in the past. This will be due to projected increases in per capita income, resulting in higher value damageable properties, and from increases in urbanization. Damage reduction benefits were adjusted to reflect increased damages in the future due to projected increases in per capita income and personal consumption expenditures according to TSC-Technical Note-Watersheds-PO-3.

Indirect floodwater damages resulting from such things as traffic detours, disruption of normal community activities, inoculations to prevent disease epidemics, etc., were based on a weighted percentage of direct damage. This percentage was developed from proportions of various types of damages, i.e., residential, commercial, and highways and bridges, in accordance with Chapter 3 of the Economics Guide and estimated at 13 percent.

Secondary benefits were computed as a percentage of primary benefits as outlined in Chapter 11 of the Economics Guide. Secondary benefits "stemming from" were estimated at 10 percent of primary benefits and those "induced by" estimated at 10 percent of annual operation and maintenance costs.

Floodrouting analysis indicated that the project would bring about a significant reduction in the area flooded in Browning. Remaining

damages are confined primarily to streets and a few low areas in the eastern part of the city. These damages are primarily the result of uncontrolled local urban runoff.

Operation and Maintenance Costs

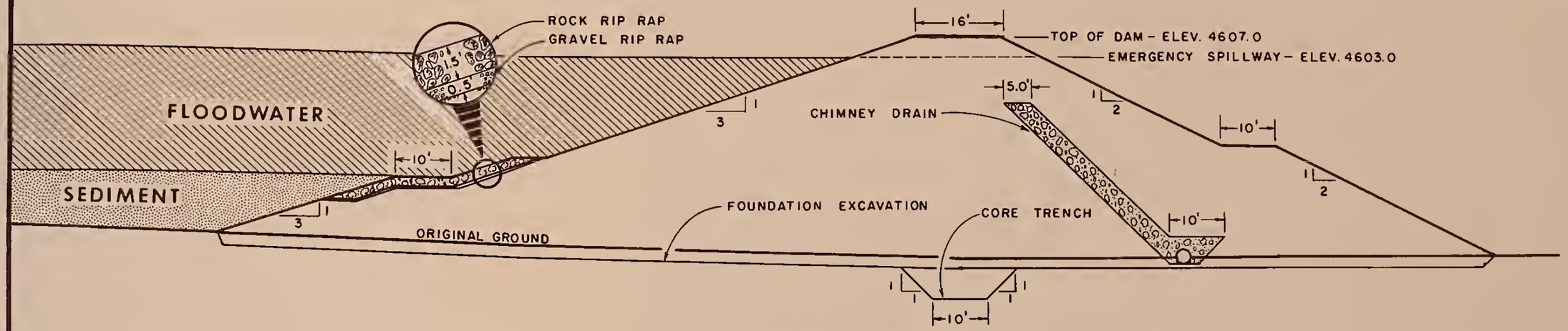
Operation and maintenance costs for structural measures were based on historical data for similar structures.

Amortization of Costs

Costs for structural measures were amortized on the basis of 6-7/8 percent over the 100-year life of the project.

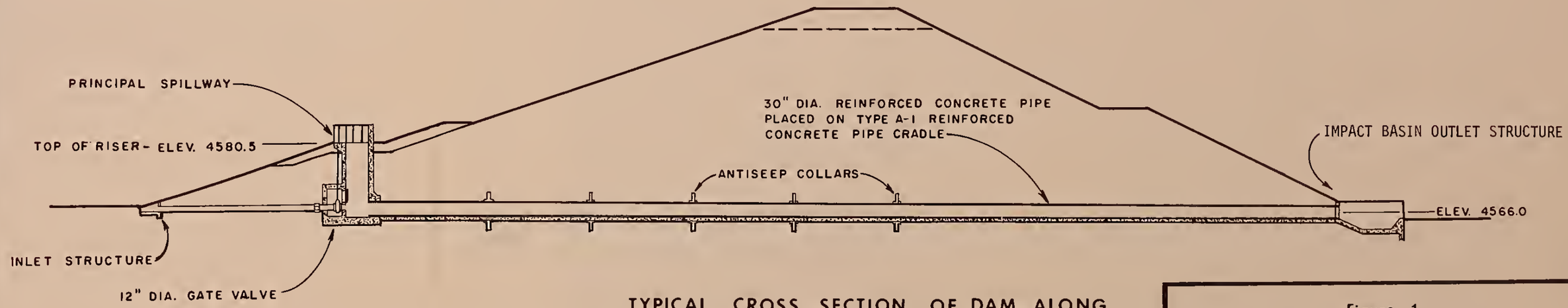
Impacts on Employment

Project effects on employment were estimated using the procedures outlined in TSC-Technical Note-Watersheds-PO-5.



TYPICAL CROSS SECTION OF DAM

SCALE: 1" = 20 FEET



TYPICAL CROSS SECTION OF DAM ALONG CENTERLINE OF PRINCIPAL SPILLWAY

SCALE: 1" = 20 FEET

Figure 1

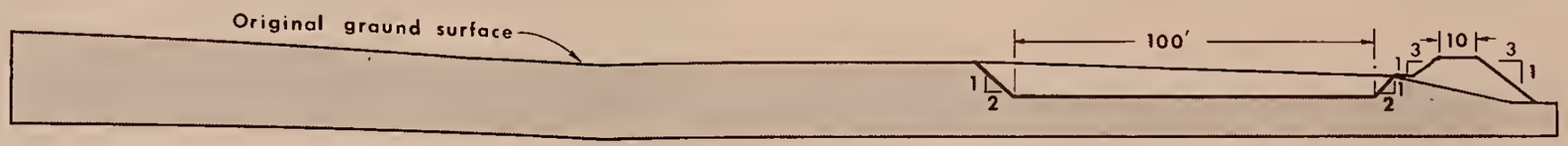
CROSS SECTIONS
WILLOW CREEK
FLOODWATER RETARDING STRUCTURE

City of Browning Watershed
Glacier County, Montana

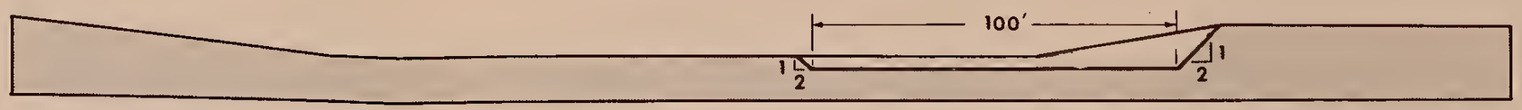
USDA-SCS-W&RB PP, Bozeman Montana

US DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



Station 4+50



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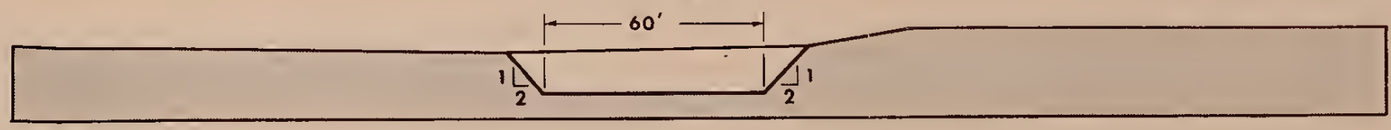

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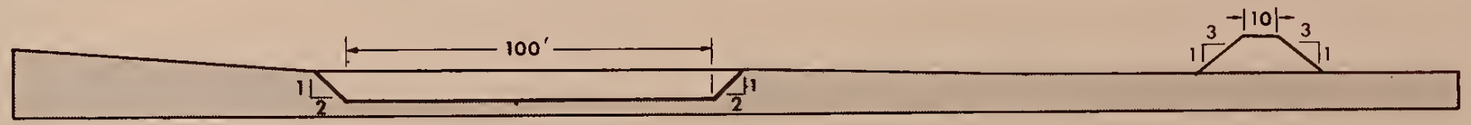
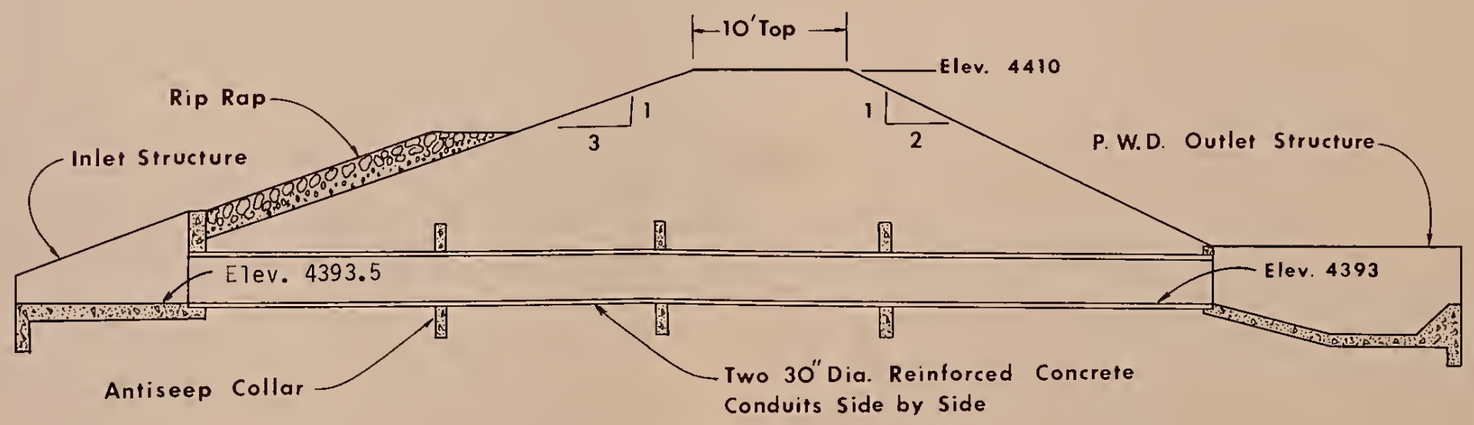


Station 53+00

NOTE: Scale of numbered sections is - Horizontal....1 inch = 40 feet
- Vertical.....1 inch = 20 feet



Typical Cross Section
of
Floodwater Control Structure

SCALE: 1 inch = 10 feet

USDA SCS W&RBPP- Bozeman Montana

FIGURE 2

TYPICAL CROSS SECTIONS UPPER FLOODWATER DIVERSION

CITY OF BROWNING WATERSHED
GLACIER COUNTY, MONTANA

T33N
T32N
R 11W
464
445
Gravel Pit Area
NEW HOUSING AREA
BLACKFEET INDIAN RESERVATION AGENCY HEADQUARTERS
N. BOUNDARY ST
W. BOUNDARY ST
C ST
D ST
E ST
F ST
G ST
H ST
I ST
J ST
K ST
3rd ST
4th ST
2nd ST
1st ST
The Museum of the Plains Indian
89
2
Lower Floodwater Diversion
Upper Floodwater Diversion
City of Browning

Note: Gravel pit area is subject to change due to continuing excavation. Flood lines established from 1971 topographic survey by S.C.S.

LEGEND

100 Yeor Flood with Project

100 Year Flood without Project

0 500 1000 1500

SCALE IN FEET
1:7920

N

Figure 3

URBAN FLOOD PLAIN MAP

CITY OF BROWNING WATERSHED

GLACIER COUNTY, MONTANA

BASE FROM 1966 AERIAL PHOTOGRAPHY

LEGEND

- Watershed Project Boundary
- Drainage Area Boundary
- Drainage Area Controled by Structure
- Area Benefited
- Floodwater Diversion Structure
- Floodwater Diversion
- Intermittent Streams
- Spring Area (Marsh)
- Municipal Water Development
- Natural Gas Line (GAS)
- Municipal Water Supply Line (WATER)
- Water Storage Tank

SCALE IN FEET AND MILES
5000' 0 1/2 1 MI.

WILLOW CREEK FLOODWATER RETARDING STRUCTURE

UPPER FLOODWATER DIVERSION

LOWER FLOODWATER DIVERSION

D.A. 9.43 Sq Mi

D.A. 0.93 Sq Mi

D.A. 15.03 Sq Mi

R12 W | R 11W

R 13 W | R 12W

R12W | R 11W

T33N
T32N

T32N
T31N

113° 07' 30"

113° 15' 00"

113° 00' 00"

48° 30' 00"

46° 30' 00"

Blackfeet Agency Headquarters

Browning

GOOSE LAKE

Willow Cr.

Flat Iron Fork of Willow Cr.

U.S. 89

U.S. 2

BURLINGTON NORTHERN R.R.

TO BABB

TO CUT BANK CHOTEAU

TO EAST GLACIER

(GAS)

(WATER)

MT 445

MT 1

CITY OF BROWNING WATERSHED

GLACIER COUNTY

Location Map

FIGURE 4

PROJECT MAP

CITY OF BROWNING WATERSHED

GLACIER COUNTY, MONTANA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Watershed Planning Party — Bozeman, Montana